Iron and Steel ENGINEER

ENGINEERING SERVICE TO THE IRON AND STEEL INDUSTRY SINCE 1907

MARCH, 1956

TECHNOLOGY DEPT.

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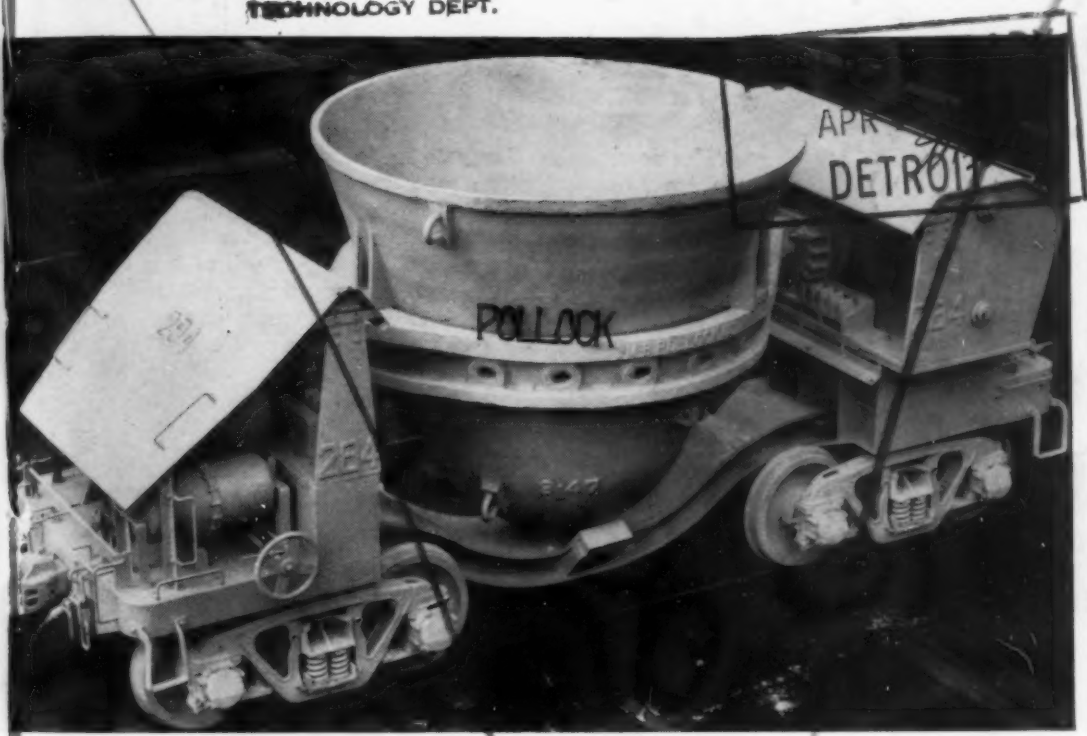
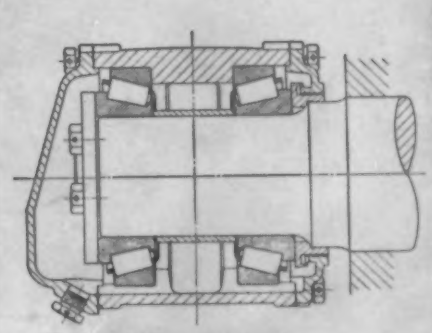




THE WILLIAM B. POLLOCK COMPANY mounts the axles of its 400 cu. ft. cinder pot cars on Timken tapered roller bearings to insure minimum maintenance and trouble-free operation.

Cinder cars on TIMKEN® bearings start faster—keep rolling longer

TIMKEN® tapered roller bearings in the journal boxes of William B. Pollock Company cinder cars reduce starting resistance by 88% when compared with friction bearings. And these cars roll easier, keep *on* rolling with minimum maintenance and lubrication, load after load, day after day.

With Timken bearings on the job, mill operators no longer need worry about scored axles and worn-out thrust washers. Friction is minimized by the true rolling motion and incredibly smooth surface of Timken bearings.

Full line contact between rollers and races gives Timken bearings tremendous load-carrying capacity. Tapered design enables them to carry any combination of radial and thrust loads. And case-hardened surfaces and tough inner-cores permit rollers and races to resist wear and take heavy shock loads. Cars stay on the job with minimum maintenance.

Because they keep housing and axle concentric, closures are made more effective in keeping lubricant in—dirt out. Timken bearings roll the load and cut the cost of lubricant and maintenance time so necessary to keep old-style friction bearings sliding.

Under normal usage, Timken bearings last the life of the car for these reasons: (1) they are carefully engineered for the job, (2) they're made of Timken alloy steel, and (3) they're precision manufactured.

No other bearings can give you *all* the advantages you get from Timken bearings. Remember, the Timken Company is America's *only* bearing manufacturer that makes its own steel. Be sure the machines you buy use bearings carrying the trade-mark "Timken". It's your assurance of high quality. The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable address: "TIMROSCO".

This symbol on a product means its bearings are the best.

TIMKEN
TRADE-MARK REG. U. S. PAT. OFF.
TAPERED ROLLER BEARINGS

NOT JUST A BALL ○ NOT JUST A ROLLER ▭ THE TIMKEN TAPERED ROLLER ▭ BEARING TAKES RADIAL ▯ AND THRUST ↔ LOADS OR ANY COMBINATION ↔

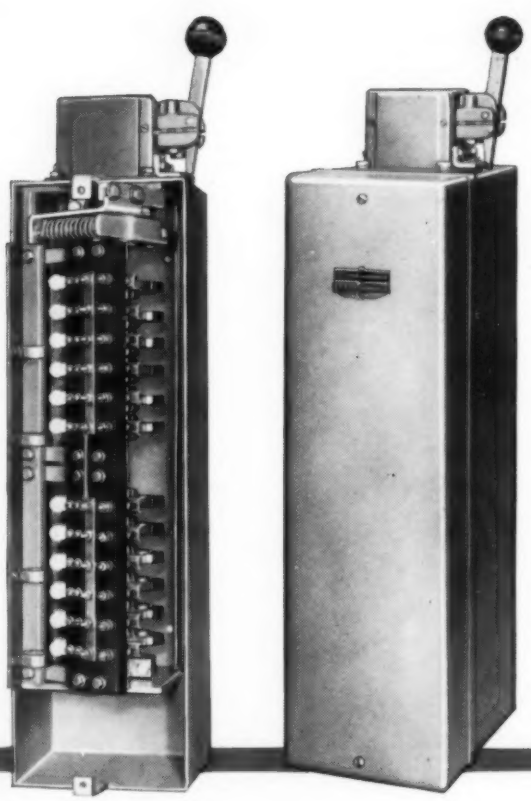
NOW— the "THIN" MASTER

for crowded cab and pulpit space

The new Cutler-Hammer Bulletin 14951 Type D Cam Master Switch measures only 7⅝ inches wide. It's designed especially for crane cab or mill pulpit use where space is at a premium. 4 of them will fit in 30 inches, all within easy reach of the operator. You can have this new master switch with bevel gear type handle which can easily be set in any one of 4 positions 90° apart. Or with radial type operating handle. Operating handle "feel" or tension is easily adjustable. Off position latch is optional. Spring return easily available. All adjustments made in field. You can have it in 6, 12, or 16 circuits. Overall case length, 16, 25¼ and 30" respectively. A maximum of 6 speed points in either direction. Available as open type for benchboard mounting, or enclosed type for base mounting.

All parts of this new master are easily and completely accessible for wiring, installation and inspection. Simply remove cover—there's ample wiring space about the terminal board. A wire way is provided on left side of terminal board. Contact fingers and cams can be removed individually—easily and quickly. This entirely new switch employs basic principles of design and construction tested and proved over many years of service in the metal working and allied industries. Save space. Save installation and wiring costs. Save operator fatigue. Get better, more dependable operation. Order bulletin 14951 *now*. CUTLER-HAMMER, Inc., 1269 St. Paul Avenue, Milwaukee 1, Wisconsin. *Associate:* Canadian Cutler-Hammer, Ltd., Toronto, Ontario.

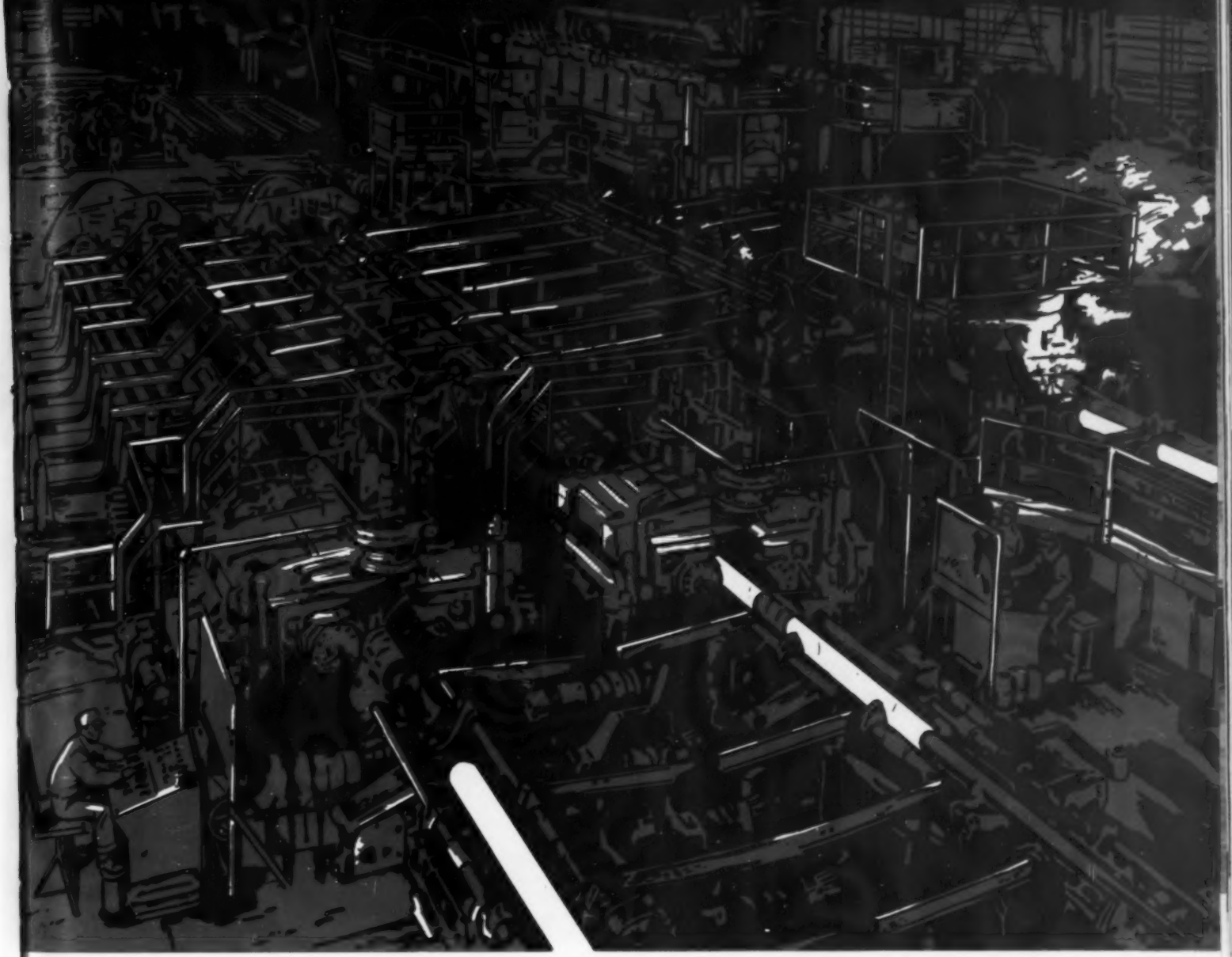
CUTLER-HAMMER
MOTOR CONTROL
C-H



Easy to install, wire and inspect

IRON AND STEEL ENGINEER; published monthly by Association of Iron and Steel Engineers, 1010 Empire Bldg., Pittsburgh, Pa. Second class mail privileges authorized at Pittsburgh, Pennsylvania, January 25, 1924.

OUR 54th YEAR OF DESIGNING AND MANUFACTURING SEAMLESS TUBE MILLS & AUXILIARY EQUIPMENT



HOW TO MAKE BETTER SEAMLESS...

● The search for better ways of making seamless never ceases . . . just as it never ceases for merchant pipe, cold rolled, galvanized, bar stock or any other product.

The formula remains the same. You concentrate on improving operating techniques. We concentrate on improving equipment. Many of the ideas for equipment originate with you and reach maturity through joint effort with us. Many new ideas originate with us and are developed with you.

How about this year? At this moment, many of Aetna's engineering hours are being expended on new ideas in seamless equipment. You will be hearing about them . . . or perhaps you already have.

AETNA • STANDARD

THE AETNA-STANDARD ENGINEERING COMPANY

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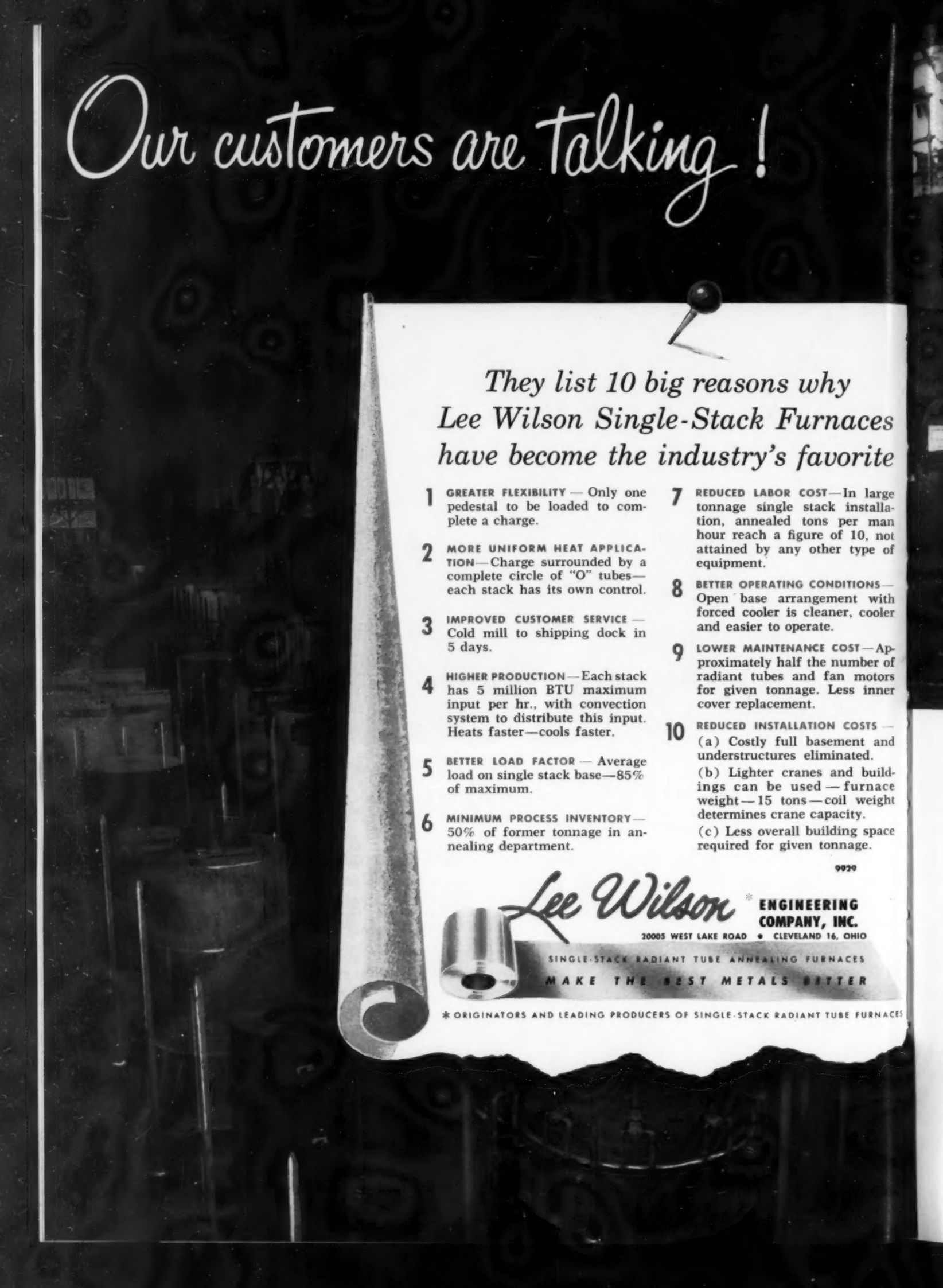
CONTINUOUS GALVANIZING LINES • CONTINUOUS ELECTROLYTIC TINNING LINES • SIDE TRIMMING AND SHEAR LINES AND OTHER FINISHING EQUIPMENT • CONTINUOUS BUTT WELD PIPE MILLS • SEAMLESS TUBE MILLS • DRAWBENCHES AND OTHER COLD DRAW EQUIPMENT • ROLLS AND CASTINGS • EXTRUDERS, MILLS, PRESSES FOR RUBBER AND PLASTIC



They list 10 big reasons why Lee Wilson Single-Stack Furnaces have become the industry's favorite

1 **GREATER FLEXIBILITY** — Only one pedestal to be loaded to complete a charge.

2 **MORE UNIFORM HEAT APPLICATION**—Charge surrounded by a complete circle of "O" tubes—each stack has its own control.

3 **IMPROVED CUSTOMER SERVICE** — Cold mill to shipping dock in 5 days.

4 **HIGHER PRODUCTION**—Each stack has 5 million BTU maximum input per hr., with convection system to distribute this input. Heats faster—cools faster.

5 **BETTER LOAD FACTOR** — Average load on single stack base—85% of maximum.

6 **MINIMUM PROCESS INVENTORY**—50% of former tonnage in annealing department.

7 **REDUCED LABOR COST**—In large tonnage single stack installation, annealed tons per man hour reach a figure of 10, not attained by any other type of equipment.

8 **BETTER OPERATING CONDITIONS**—Open base arrangement with forced cooler is cleaner, cooler and easier to operate.

9 **LOWER MAINTENANCE COST**—Approximately half the number of radiant tubes and fan motors for given tonnage. Less inner cover replacement.

10 **REDUCED INSTALLATION COSTS** —
(a) Costly full basement and understructures eliminated.
(b) Lighter cranes and buildings can be used — furnace weight — 15 tons — coil weight determines crane capacity.
(c) Less overall building space required for given tonnage.

9929

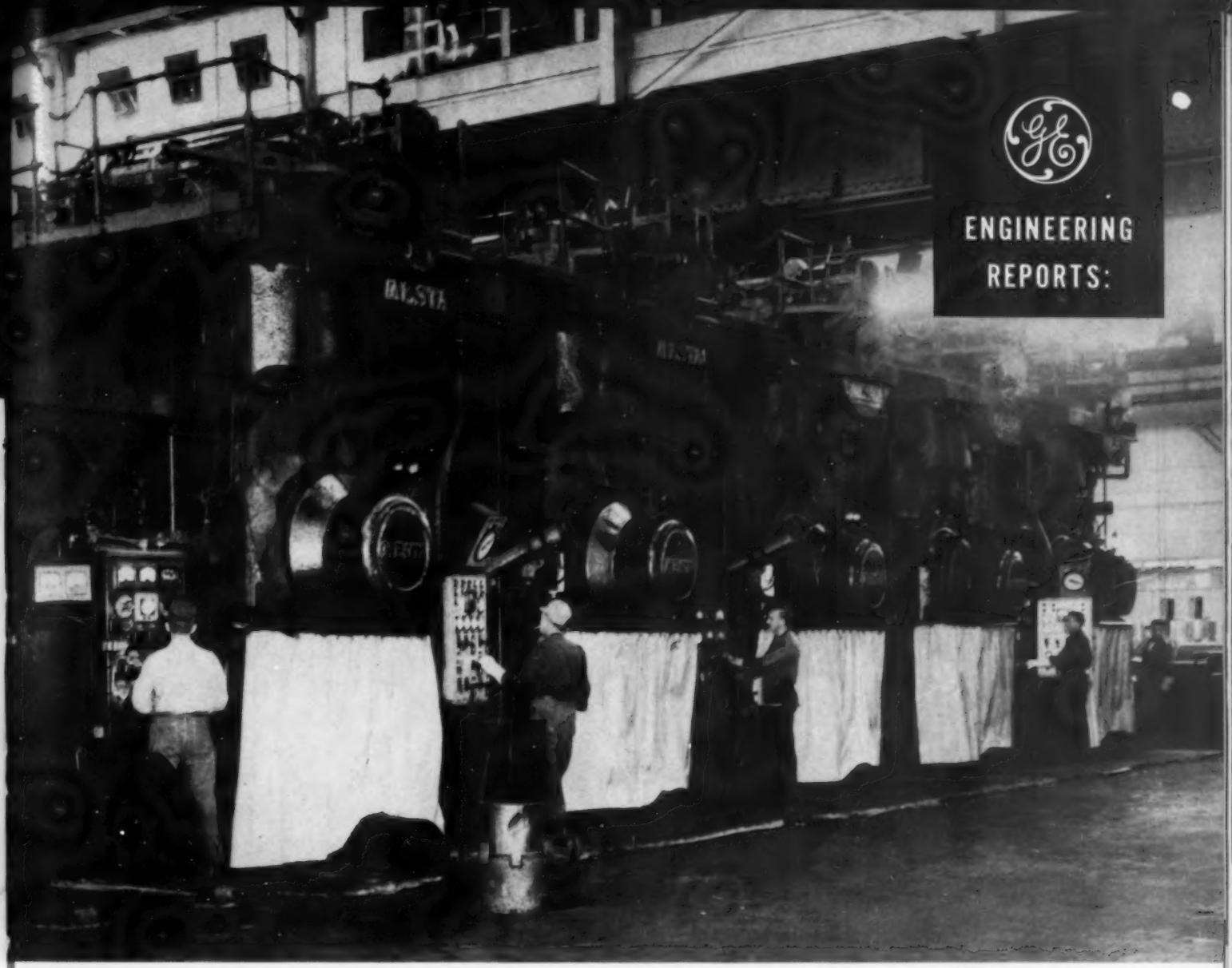
Lee Wilson* ENGINEERING COMPANY, INC.

20005 WEST LAKE ROAD • CLEVELAND 16, OHIO

SINGLE-STACK RADIANT TUBE ANNEALING FURNACES

MAKE THE BEST METALS BETTER

* ORIGINATORS AND LEADING PRODUCERS OF SINGLE-STACK RADIANT TUBE FURNACES



FIVE-STAND TANDEM MILL at U.S. Steel's Irvin Works incorporating an automatic gage control system

At U.S. Steel: NEW G-E Automatic Gage Control Improves Steel Strip Quality

An automatic gage control system for closer, continuous control of cold reduction mills producing sheet and strip products, has been developed through the co-operative efforts of the United States Steel Corporation and the General Electric Company. The system, now in use at U.S. Steel's Irvin Works, Dravosburg, Pa., improves the thickness uniformity of cold-rolled steel strip produced at a rate up to 4000 fpm.

Increasing applications of high-speed continuous sheet and strip mills in the steel industry emphasize the need for automatic control of thickness. To solve the problem, a joint research and development study of cold reduction mill controls was instituted by United States Steel and General Electric.

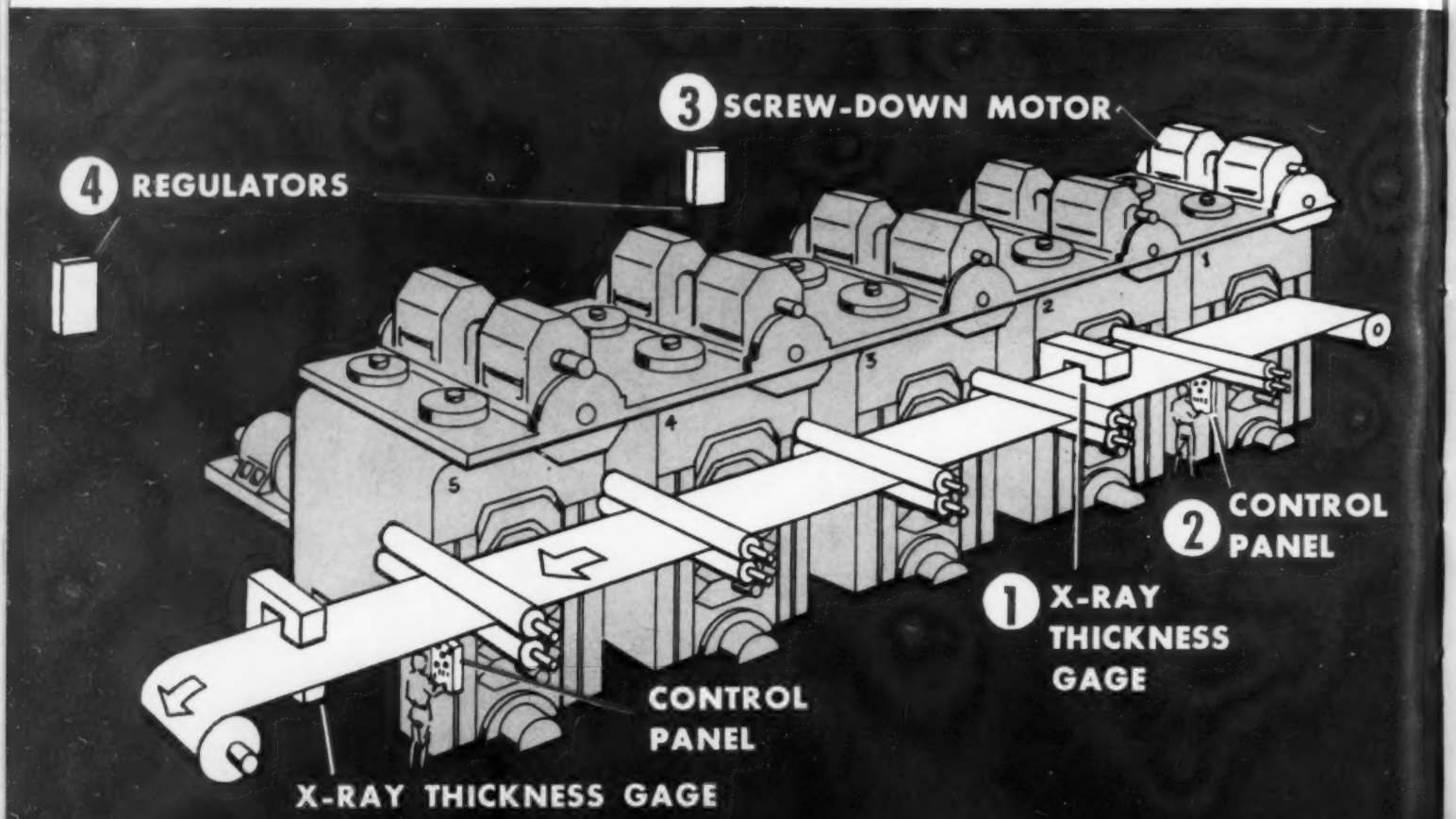
Before attempting to design any system, G-E application engineers set up the problem on an "electronic brain" for study of the complete mill thickness problem and drive system. The analysis took into account all electrical constants, changes in roll pressure and interstand tension. Components of the resulting system design were constructed by G.E.'s Industry Control and X-Ray Departments.

This new installation is the first over-all thickness control in the steel industry to utilize a screw-down control to vary stand 1 reduction, but also a vernier system operating on the roll speed of the last stand. With this arrangement, thickness variations in the finished product can be held smaller than was ever possible by manual means.

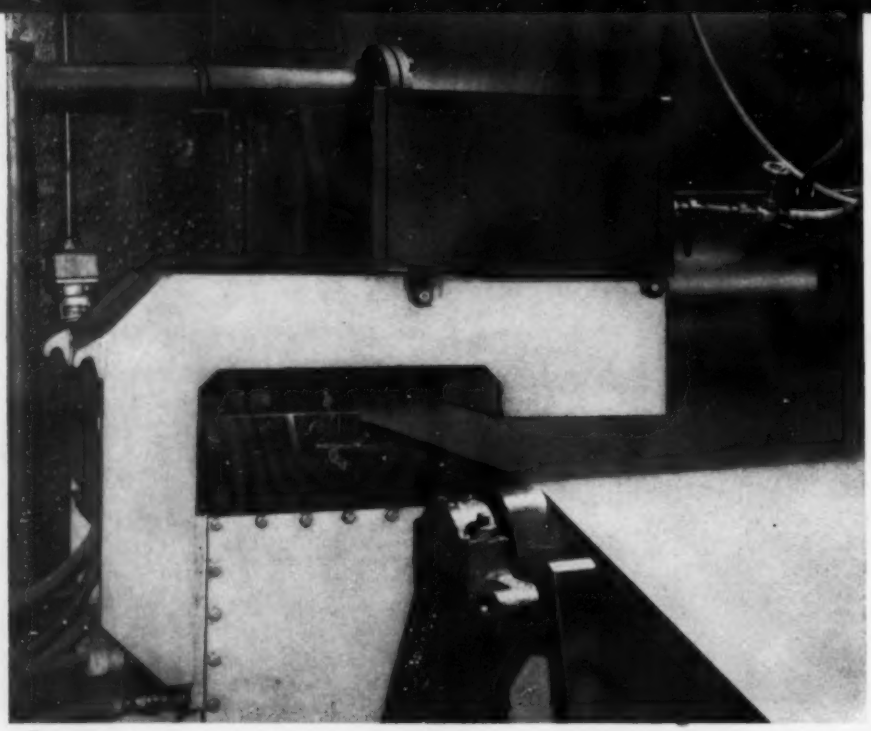
TURN PAGE FOR SYSTEM STORY ▶

GENERAL ELECTRIC

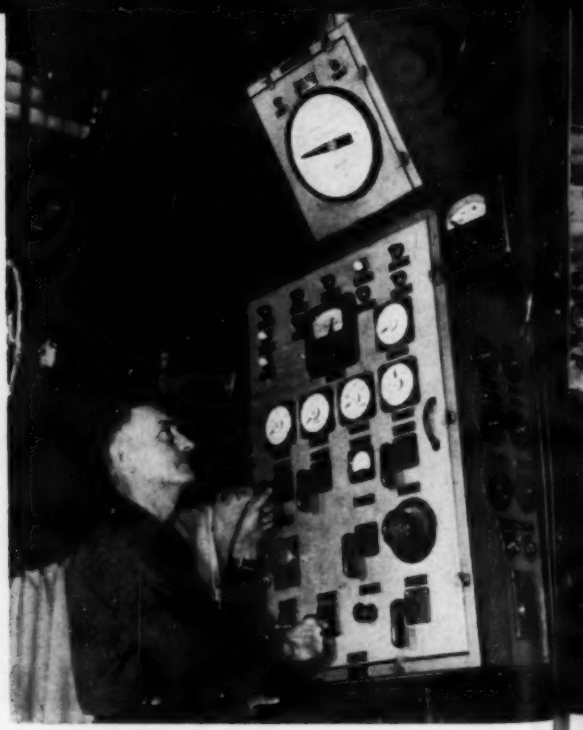
G-E system automatically controls steel



SYSTEM-DESIGNED COMPONENTS



1 **G-E 50-KV X-RAY THICKNESS GAGE** is shown partly retracted from gaging position. Each gage is mounted on a truck which retracts gage for servicing and maintenance.



2 **THE TWO OPERATORS'** control cabinets contain the controls and instruments to set up and observe drive system functions.

strip thickness, permits closer tolerances

The x-ray gage system actually operates as a "watch dog" during the rolling of the strip and is integrated into the rolling process as shown in the illustration at left.

Here's how it works: Control of stand 1 originates in an x-ray gage between stands 1 and 2. The strip passes between the x-ray unit and a detector unit. The desired thickness of the steel sheet is set on a dial of the gage. The actual thickness of the steel is then measured by the x-ray gage, and deviations from the desired thickness are brought to the automatic control panel in the form of an electrical signal.

This signal activates a transistor discriminator in the automatic control which determines the direction of the error, whether heavy or light, and also the degree of the error. The discriminator emits a signal which is fed into on-and-off time circuits. The resulting signals then operate the up and down relays of the stand 1 screw-down motors, which run in the required direction to correct the steel thickness.

A 50-kv x-ray thickness gage similar to the one used between stands 1 and 2 measures and initiates control of the thickness of the strip leaving stand 5 before it is wound on the reel.

On this mill the stand 5 direct current armored mill motor receives its power from a common source which also supplies power to the other mill stand motors. Stand 5 speed can be varied automatically in relation to previous stand motor speeds, thus adjusting the thickness of the material leaving stand 5 through variation of tension between stands 4 and 5.

In actual operation, mill is set up manually by operators. Coarse and vernier settings of the motor-field current regulator of the gage system are then set to approximate desired output thickness. During rolling the regulating systems are continuously in control of product thickness and make corrections for all deviations.

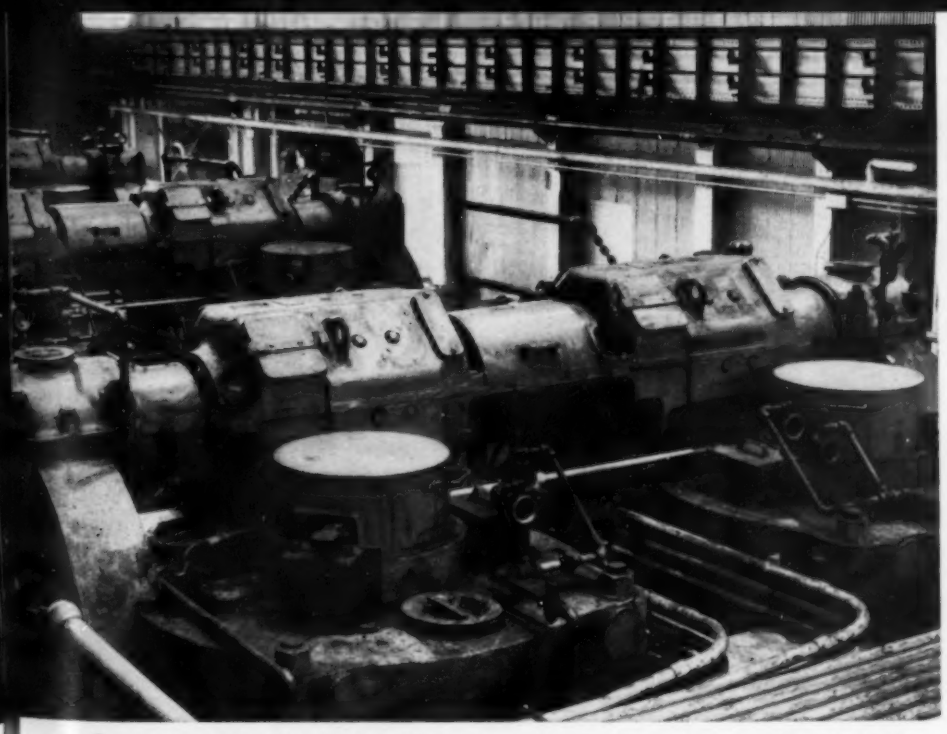
This new automatic gage control system was designed to provide a better product, minimize waste due to off-gage material, augment skill, experience and knowledge of the head roller and relieve crew members of adjusting manual controls.

If you are planning to build, modernize, or expand your facilities, the same G-E "know-how" which went into this system is available to you. For further information contact your local G-E Apparatus Sales Representative, General Electric Co., Schenectady 5, New York. 659-112

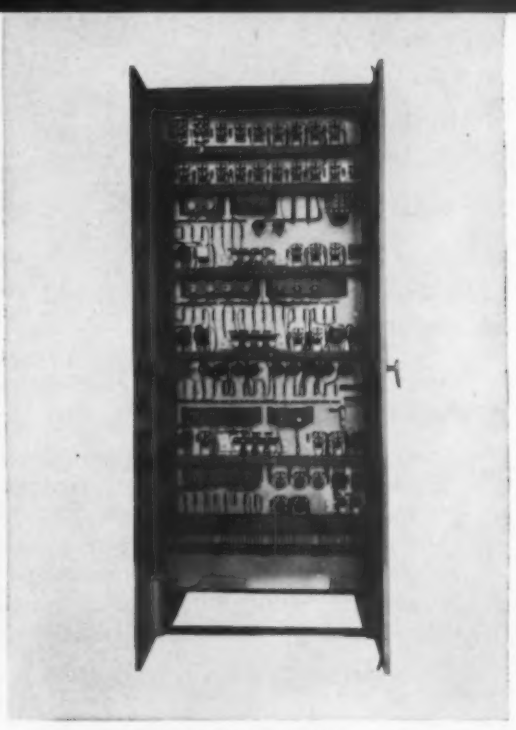
Engineered Electrical Systems for Steel Mills

GENERAL ELECTRIC

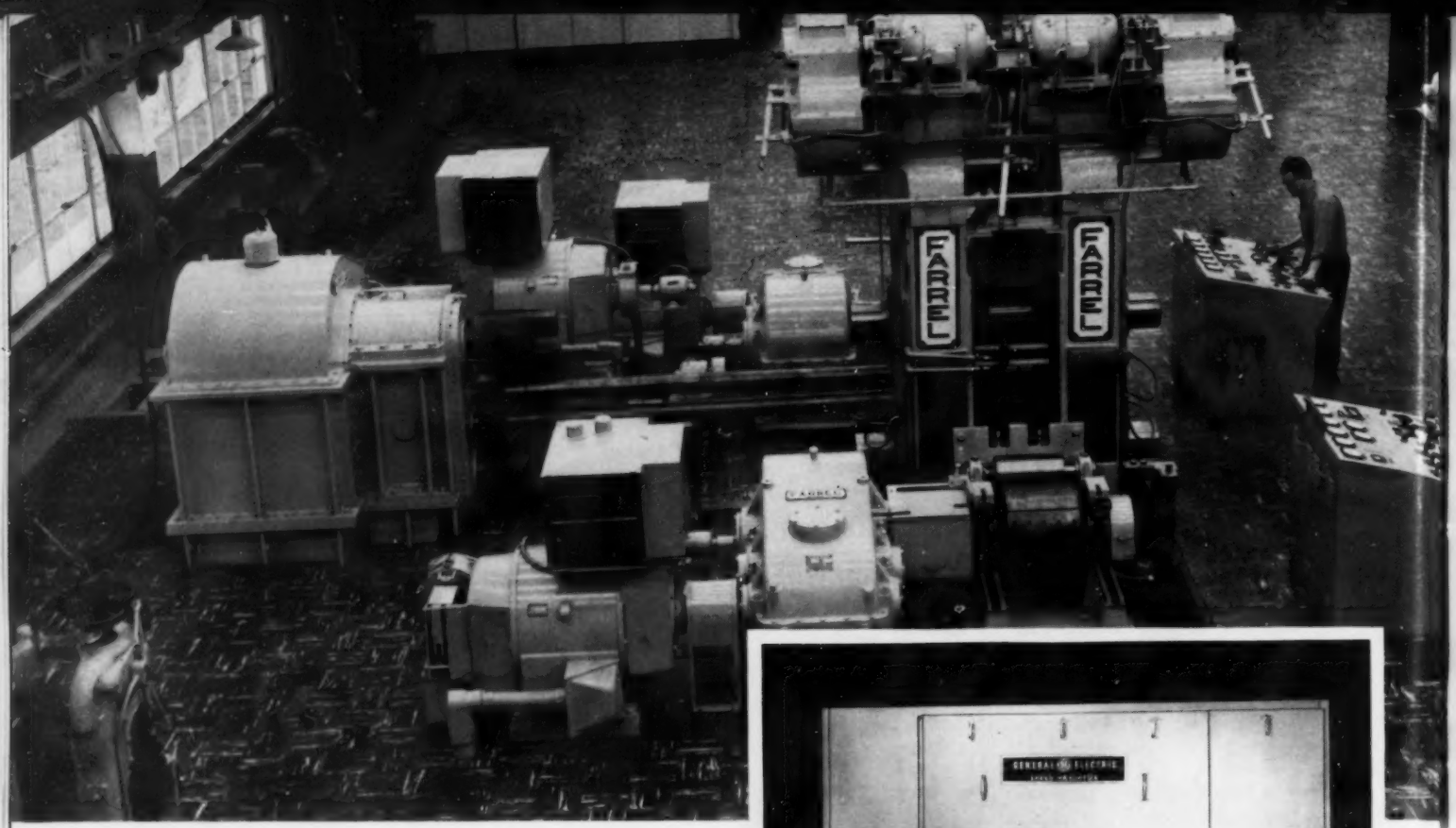
INTEGRATE ROLLING PROCESS

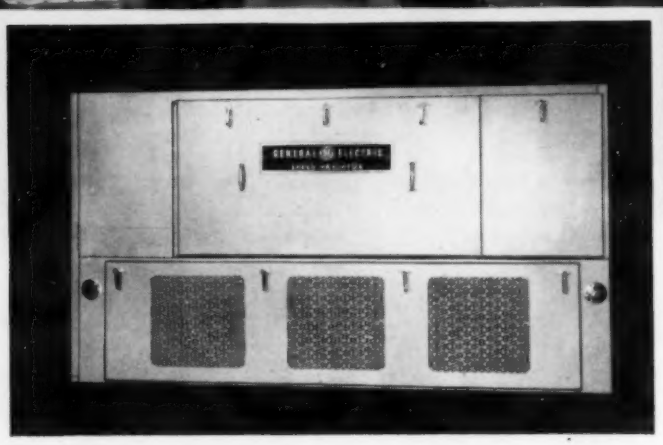


3 THE SCREW-DOWN MOTORS on stand 1 operate as an integral part of the automatic gage control. A screw-reset function automatically returns the screws to their initial position after the coil tail-end leaves the mill.



4 THE REGULATING SYSTEM was designed on the basis of transistor and magnetic-amplifier techniques and components.





Controlled d-c power for this development laboratory reversing cold strip mill is supplied entirely from G-E Speed Variators. The main m-g set and controls are housed in compact steel cabinets (right), requiring no foundation. These packaged units are engineered to meet your special requirements.

NOW AVAILABLE FROM GENERAL ELECTRIC

Packaged Speed Variators Built to Large Rolling Mill Standards

COMPLETE ENGINEERING APPLICATION SERVICE TO MEET YOUR SPECIAL REQUIREMENTS

Built to large rolling mill standards, General Electric Speed Variators are now available for special drive applications up to 500 hp. Using circuits originally developed for large rolling mills they offer close, accurate control with great reliability and high overload capacity.

Complete engineering services offered for large mill installations are available with Speed Variator applications. G-E specialists will arrange operator's control station or desk layout to meet your special requirements. Regulating equipment can be adapted to various rolling mill characteristics. For example, this reversing cold strip mill can be used as a 4 high mill with 3- or 6-inch work rolls or can be used as a 2 high mill with 21-inch work rolls.

Factory wired and tested, the Speed Variator power unit comes ready to be installed. Drive components include operator's control station, power unit and drive motors. The rugged all steel cabinet of the power unit contains m-g set and controls in a compact enclosure.

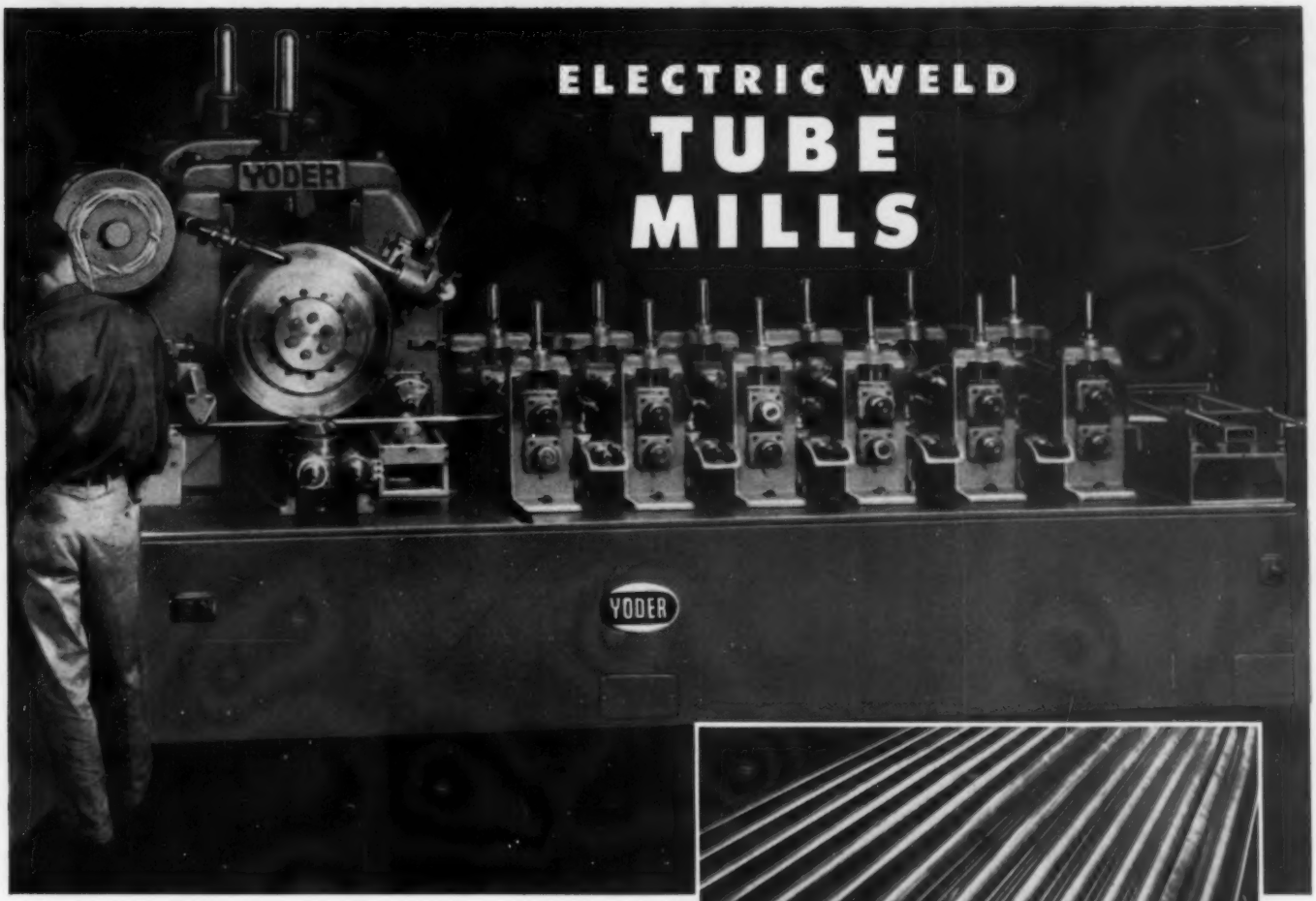
Find out how this flexible, packaged source of d-c power can be used to best advantage in your mill. G-E engineers, specialists in steel applications, are at your service. Contact your G-E Apparatus Sales Office. *Direct Current Motor and Generator Department, General Electric Company, Erie, Pennsylvania.*

820-1

Progress Is Our Most Important Product

GENERAL ELECTRIC

ELECTRIC WELD TUBE MILLS



The photo shows the tube forming mill and welder of a complete Yoder mill recently installed for an Italian customer. Although it looks very much like a standard Yoder mill, it embodies special mechanical and electrical innovations designed for *tube production at speeds up to 350 fpm*—from 200 to 300% faster than heretofore considered practical by the resistance-weld process.

This is just one example of the many new things introduced by Yoder in pipe and tube making equipment, to meet widely varying production needs. Other recent Yoder developments are induction weld mills for making steel as well as nonferrous pipe and tubing, at speeds never before approached by this process, and adding greatly to its recognized economic advantages.

For more complete information about the latest technological advances in Yoder tube mill equipment, write, wire or phone

THE YODER COMPANY
5495 Walworth Ave. • Cleveland 2, Ohio

Literature on Request:

- ☐ **1.** Electric Weld Tube Mills for *Steel Tubes* up to 4" diameter.
- ☐ **2.** *Induction Weld* Tube Mills—sizes up to 8" diameter for aluminum, nickel, copper, brass, inconel, monel, stainless and other alloys.
- ☐ **3.** *Pipe Mills*—electric weld—for sizes up to 24" diameter.

ENGINEERING YODER MANUFACTURING

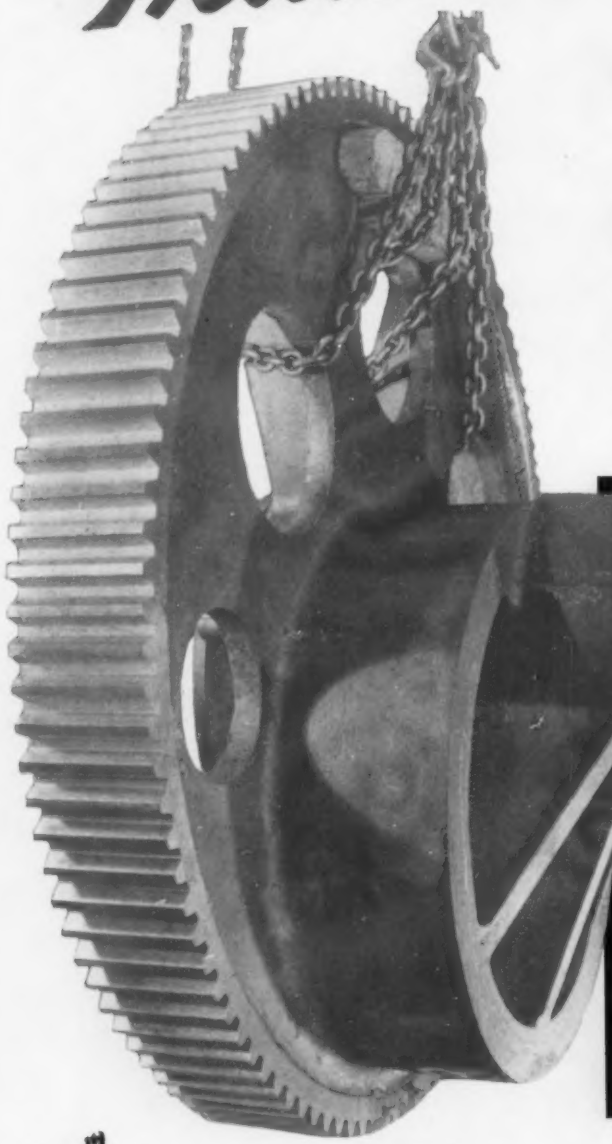
PIPE AND TUBE MILLS—Electric Weld

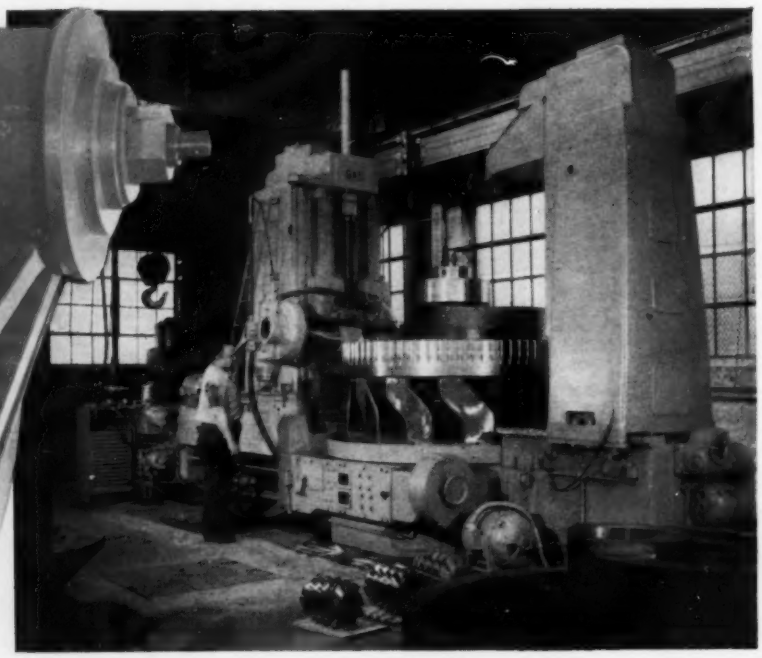
ROTARY SLITTING LINES
COLD ROLL FORMING MACHINES

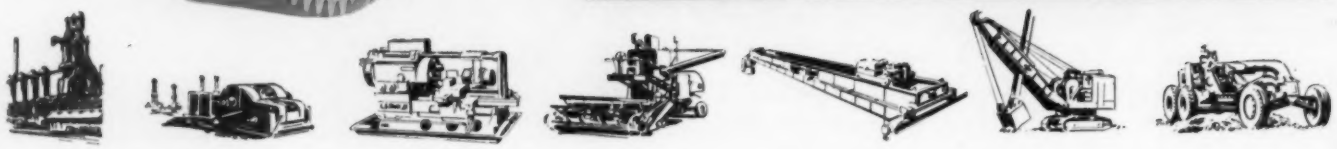
"Industrial Gear"

BIG HOBBER READY TO CUT YOUR HEAVY-DUTY GEARS

We operate day and night to give you the kind of service you need. Our plant is equipped with the finest and most up-to-date machines for the cutting of any type gear.







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Our plant, devoted exclusively to gear and sprocket cutting, can be visited pictorially. Write for Brochure showing the vast assemblage of equipment ready to serve you.

Let us go over your gear needs with you or send us your blue prints for a trial run.

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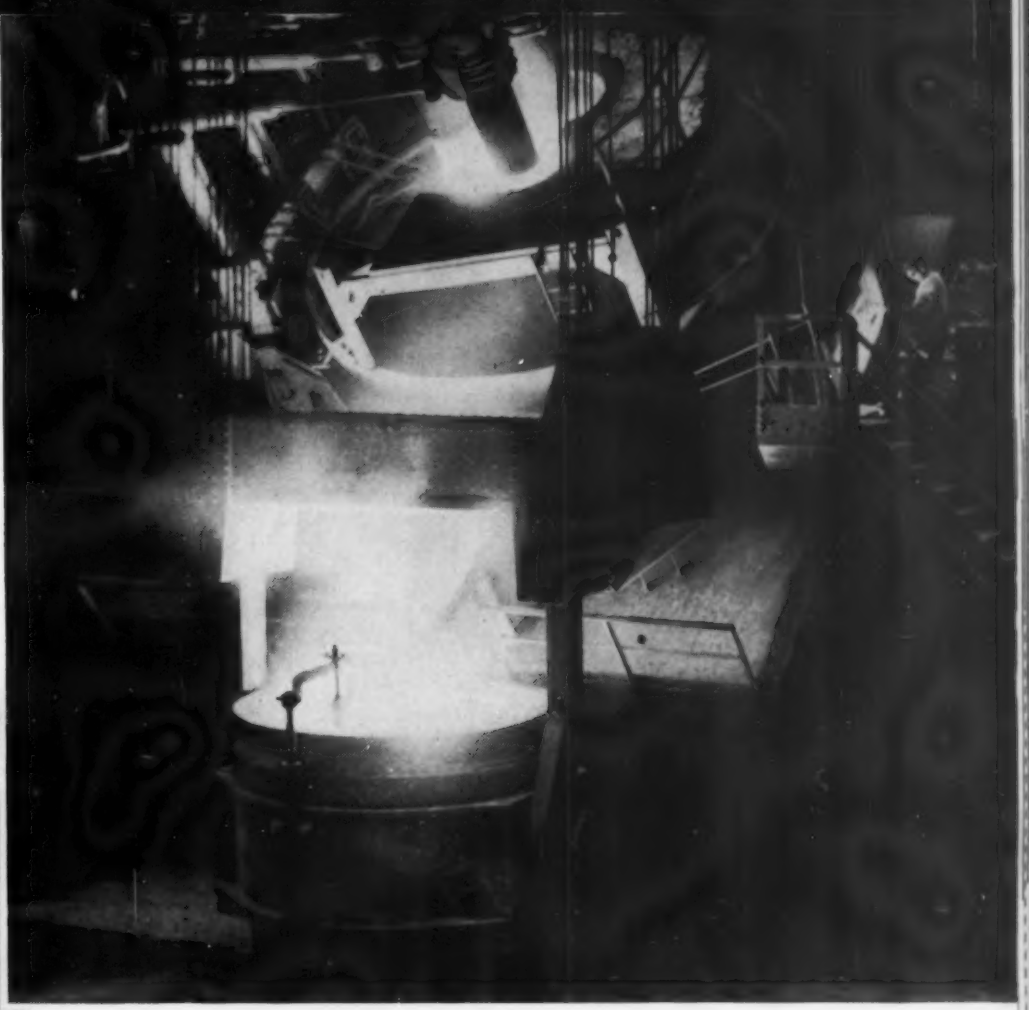
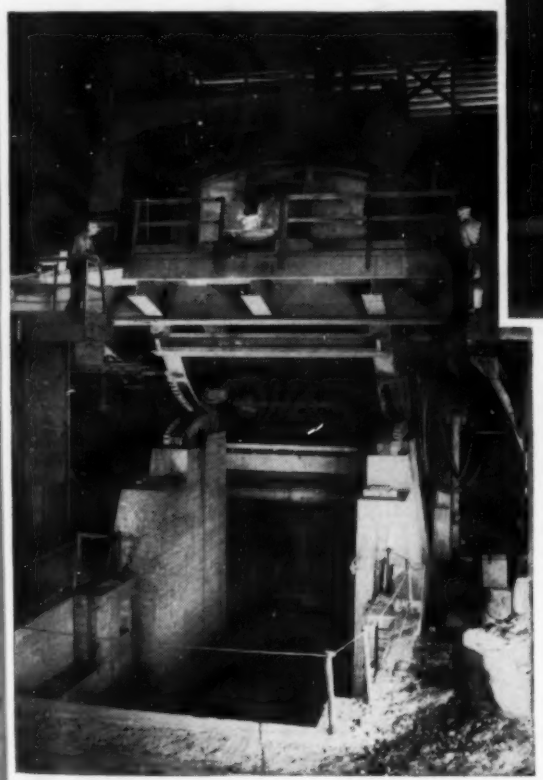
ELECTRIC MELTING FURNACES

TOPS FOR PRODUCTION OF HIGH GRADE STAINLESS, ALLOY AND RIMMING STEELS





This free Catalog will help you determine how Heroult Electric Furnaces can improve your operation . . . and enable you to make better quality steels. Tells you where and when an electric furnace is desirable. Gives furnace types, sizes, capacities and ratings. For your free copy, just contact the office nearest you, or write direct to Pittsburgh.

You can make better quality steel faster with the Heroult!

If you're faced with the need for higher production . . . and a higher grade of steel . . . in order to improve the competitive position of your mill, the modern Heroult electric furnace can prove a mighty profitable investment for you.

Embodying the latest in mechanical and electrical equipment, these widely accepted furnaces are noted for their efficient performance and low operating and maintenance costs.

Available in sizes of shell diameter ranging from 7'0" up to 24'6", and with rated charge capacity of from 8000 lbs. up to 400,000 lbs., they are equipped with removable roofs to permit top charging. Both gantry and swing-type roof-removing mechanisms are available. Door-charging furnaces and furnaces of special design, including units equipped with austenitic steel bottoms to permit inductor stirring, can be supplied.

We welcome an opportunity to help you select and install the Heroult best suited to your needs. Please remember, however, that because the Heroult is a precision-engineered unit . . . made to order . . . to fit your particular requirements, it is advisable to anticipate your future needs as far in advance as possible. *The Heroult we make and install for you will be the finest electric furnace that money can buy!*

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United States Steel Export Company, New York

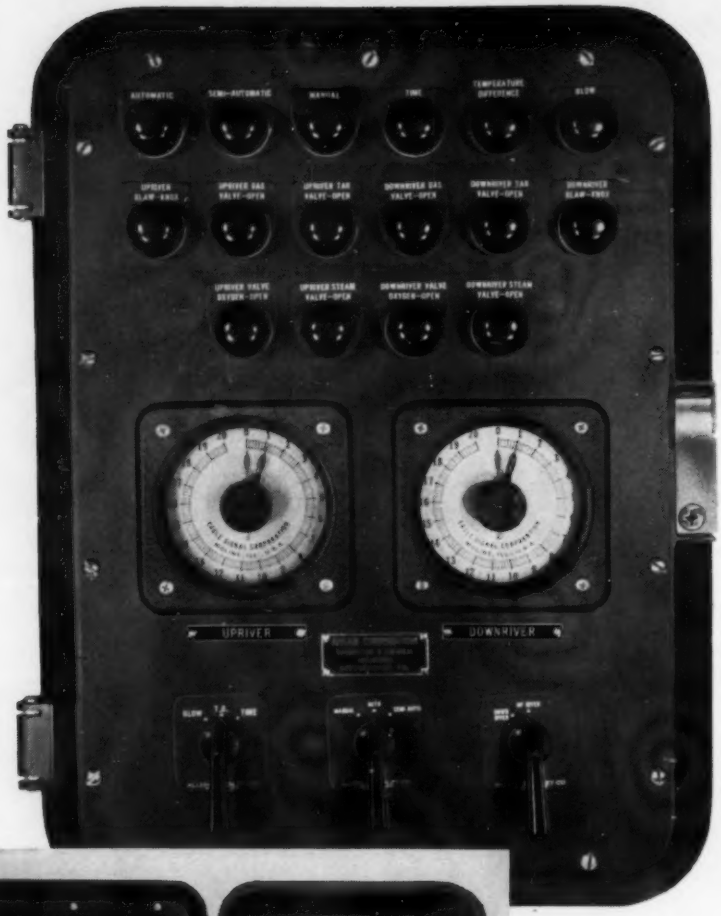
SEE THE UNITED STATES STEEL HOUR. It's a full-hour TV program presented every other week by United States Steel. Consult your local newspaper for time and station.

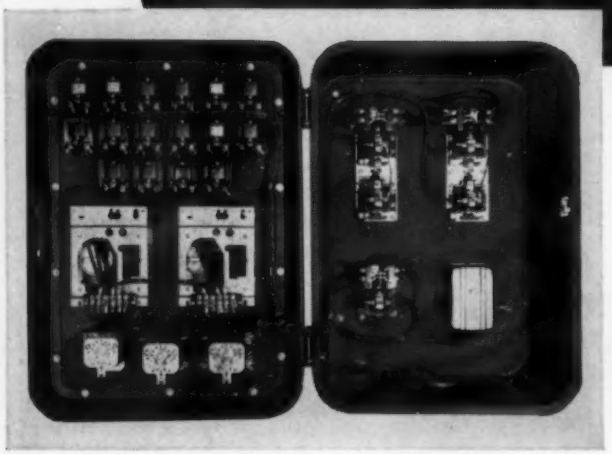
USS

UNITED STATES STEEL

Hagan Automatic Reversal Control

for open hearth furnaces





Latest addition to the Hagan line of metallurgical furnace controls is the Automatic Reversal Control. Accurate and reliable as are all Hagan components, the Hagan Automatic Reversal Control offers the following outstanding features:

COMPACT—The entire control system, including signal lights which show the minute-by-minute operation of the control, is contained in a single case, 16⅜" wide by 22⅛" high by 13⅜" deep.

COMPLETE—The Hagan Automatic Reversal Control can be set for automatic, semi-automatic or manual operation. Either time cycle or temperature difference may be used as the prime reversal control.

The control is entirely electric, and may be used with either pneumatic or hydraulic valve operators.

MULTIPLE FUEL—The control handles single or multiple fuel installations, as well as steam and oxygen. Timing of each is set up for minimum loss of firing time during reversal.

SAFE—The Hagan Automatic Reversal Control includes safety interlocks which protect the installation regardless of whether control is automatic, semi-automatic or manual.

Ask your Hagan engineer about the new Hagan Automatic Reversal Control, and about the many other Hagan devices specifically designed for metallurgical furnace combustion control.

HAGAN CORPORATION

HAGAN BUILDING, PITTSBURGH 30, PA.

HAGAN

Systems and Components for: Metallurgical Furnace Control, Boiler Combustion Control, Process Control, Aeronautical Testing Facilities • Industrial Water Treatment • Chemicals for Water Conditioning

HAGAN SUBSIDIARIES: CALGON, INC. • HALL LABORATORIES, INC.

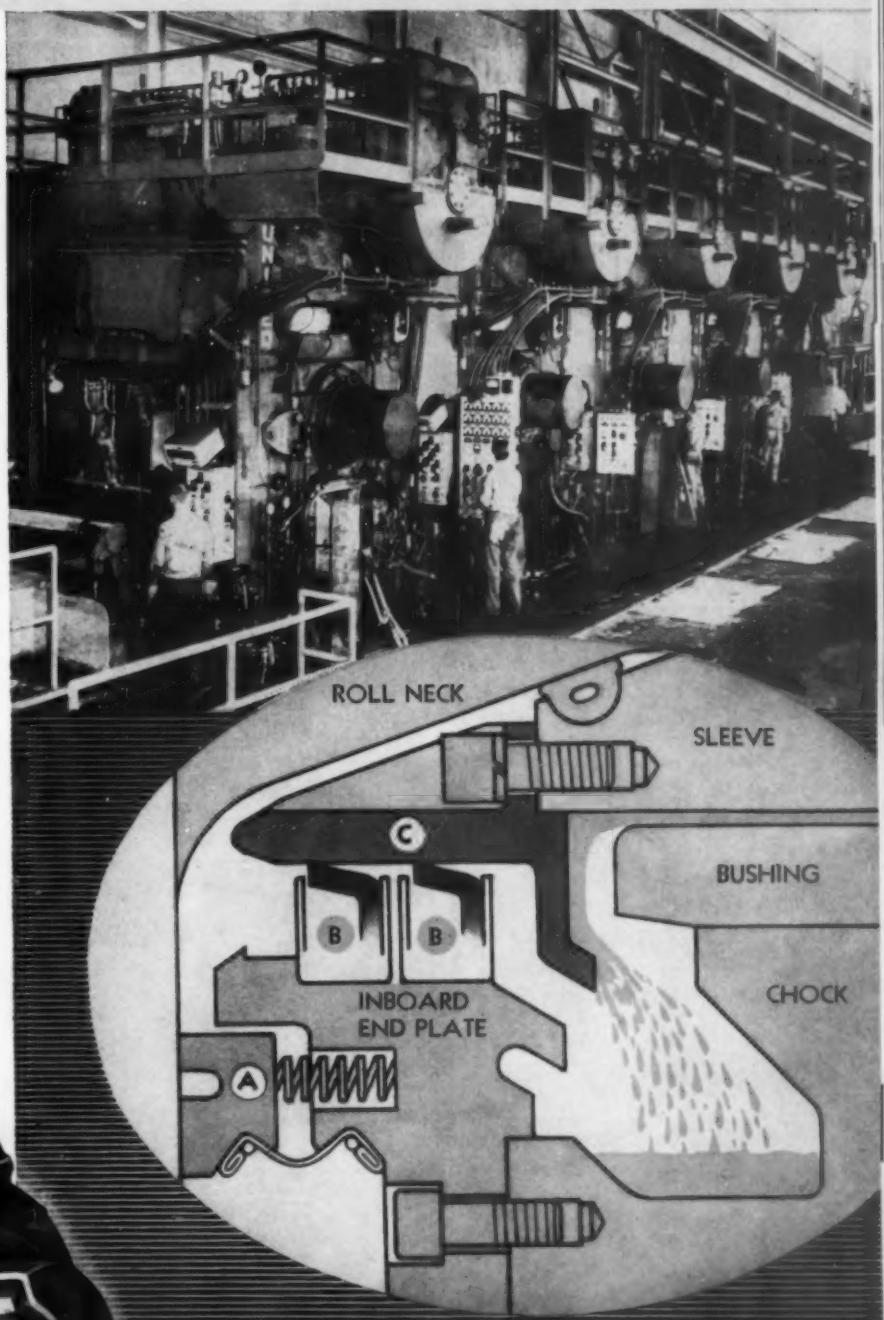
The MORGOIL FLINGER

Stops oil loss on mills using rolling lubricant

The rotating sleeve extension and flinger "C" throws all of the oil from the bearing into the drain sump. **No more oil loss through worn seals.**

The water seal assembly "A" and the oil seals "B" of a modern MORGOIL serve only one purpose — to keep rolling lubricant out of the bearings.

This five stand tandem four-high cold mill at Kaiser Steel Corp., Fontana, California rolls on modern MORGOILS equipped with sleeve extensions and flingers.



MORGAN CONSTRUCTION COMPANY

WORCESTER, MASSACHUSETTS

ROLLING MILLS MORGOIL BEARINGS GAS PRODUCERS
WIRE MILLS EJECTORS REGENERATIVE FURNACE CONTROL

English Representative
International Construction Co., 56 Kingsway, London W. C. 2, England

MB-28R

MORGOIL

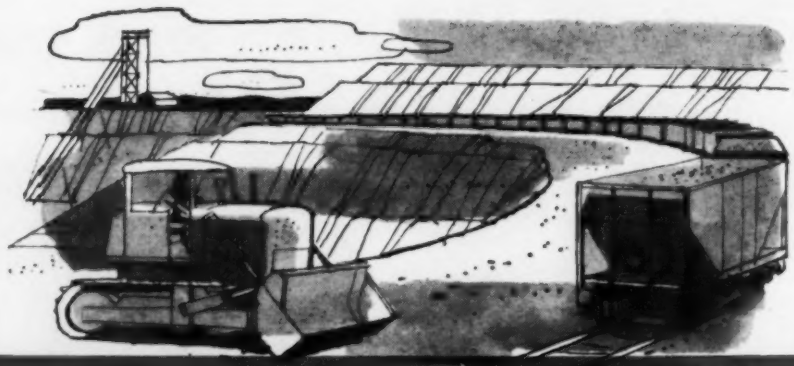
the best Roll Neck Bearing you can buy

From Mine to Mill . . .

Allis-Chalmers Equipment serves in every part of the Steel Industry . . . Dependably, Economically

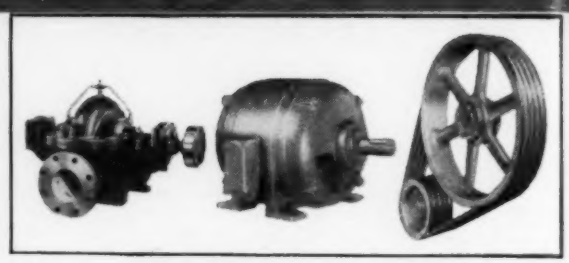
For more than three quarters of a century, Allis-Chalmers has served the steel industry — supplying the equipment needed to produce top quality steel . . . the manufacturing "know-how" to meet heavy-duty operating conditions . . . the pioneering spirit to keep up with the changing requirements of the industry. Allis-Chalmers machines are employed, not just in one phase, but all through the steel-making process. For complete information on how Allis-Chalmers can help solve your machinery problems, consult your Allis-Chalmers district office or write Allis-Chalmers, Milwaukee 1, Wis.

Regulex and *Texrope* are Allis-Chalmers trademarks.

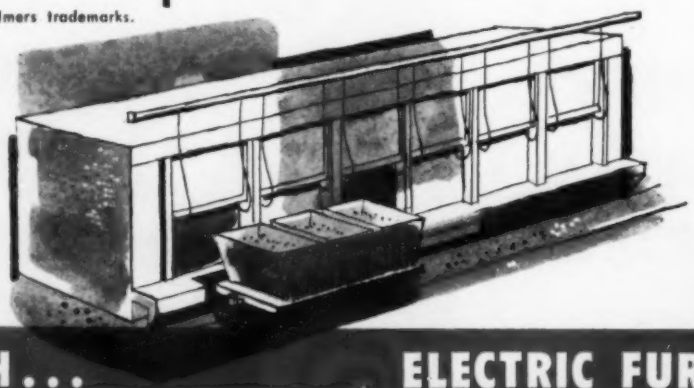


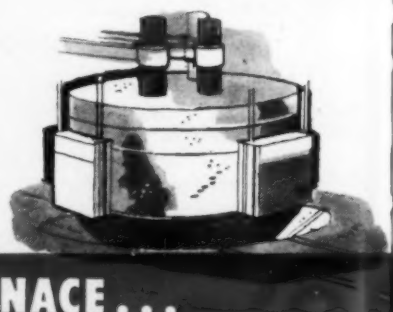
MINES . . .

Crushers, grinding mills, vibrating screens engineered and manufactured by Allis-Chalmers crush the ore-bearing rock, grind it to specified size, size and wash metallic ores, stone and coal.

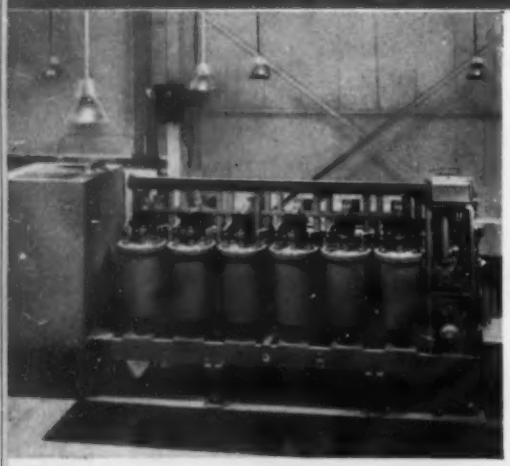


Allis-Chalmers pumps, motors, *Texrope* drives are in wide use throughout the metal industry because of their long life characteristics, low maintenance requirements and great versatility.

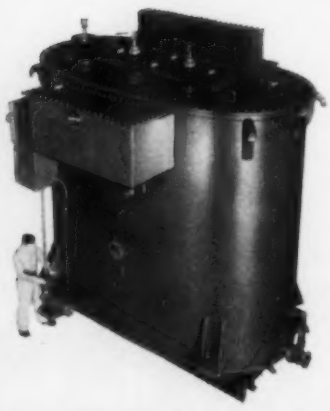




OPEN HEARTH . . . ELECTRIC FURNACE . . .

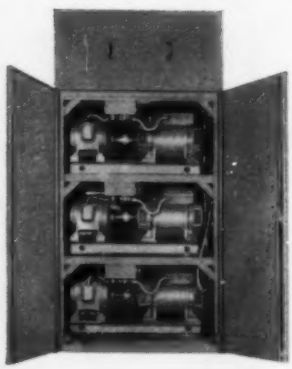


Mercury-arc rectifiers furnish constant voltage dc power for material handling in open hearth and other mill operations and for mine haulage. Variable voltage units are supplied for supporting main roll drives.



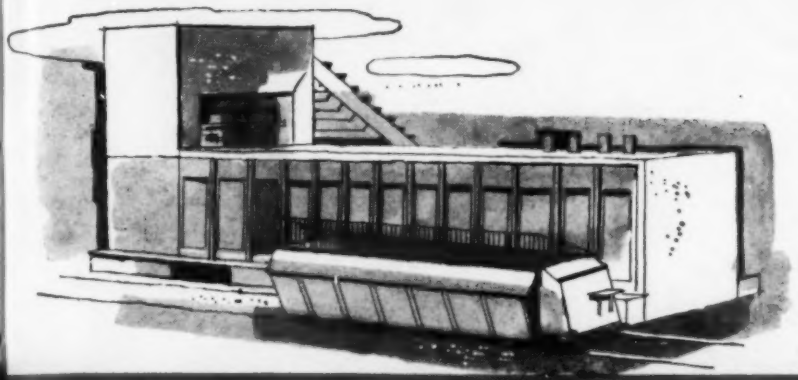
Allis-Chalmers arc furnace transformers are of well-balanced design and extra heavy duty construction — proven in 25-30 years of repeated daily short-circuits in electric furnace operation.

***Regulex* control** balances arc current with arc voltage, almost instantly — maintains desired arc condition automatically.

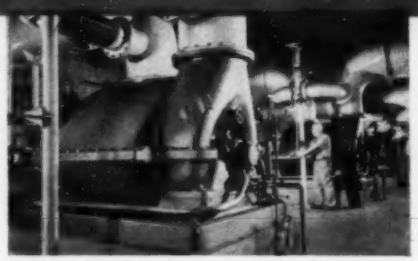


ALLIS-

. . It's Allis-Chalmers

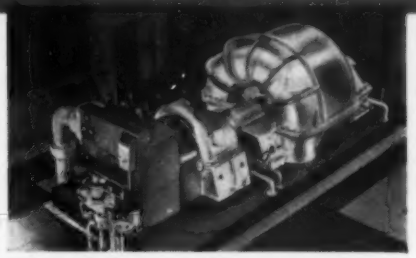


COKE OVEN...



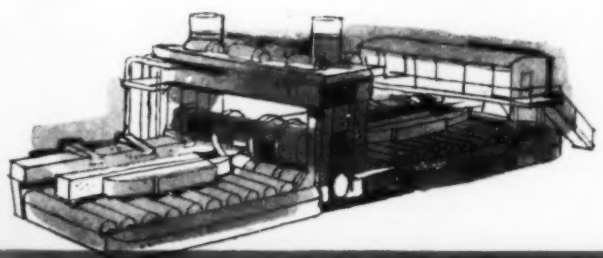
Booster, exhauster or combination service requirements are met by Allis-Chalmers blowers. Photo shows four 23,000-cfm, 5100-rpm, 3.5-psig centrifugal exhausting blowers in a western steel mill.

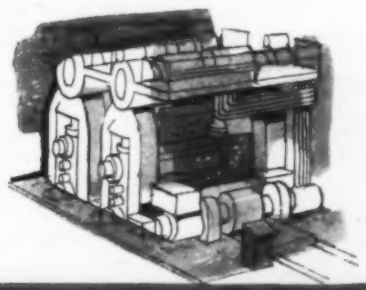
BLAST FURNACE...



Blast furnace blowers furnished by Allis-Chalmers meet blast furnace requirements. The 75,000-cfm, 30-psig centrifugal blower shown here has been in service since 1942. It is driven by an 8500-hp steam turbine.

Allis-Chalmers axial blowers are designed for high efficiency blast furnace duty. They are smaller, easier to install — save $50,000 or more in steam per year. A-C also builds constant efficiency rotary compressors.





BLOOMING MILL...

Motor room photograph shows Allis-Chalmers switchgear, control, constant and variable voltage motor-generator sets, *Regulex* m-g sets, liquid rheostat, and twin-drive motors in use in a midwestern steel plant.

FINISHING MILLS...

Hot strip, cold reduction, temper, rod and wire mills, and annealing and pickling lines employ Allis-Chalmers control, power equipment and drive motors for dependable operation.

Other Equipment

Besides the power utilization and conversion equipment illustrated, Allis-Chalmers also supplies power generation and distribution requirements from mine to mill.

For power generation, A-C builds steam turbine-generator units, surface condensers, water conditioning equipment, pumps, motors, and control. Also hydraulic turbines, generators, governors, and valves. For power distribution, A-C furnishes transformers, voltage regulators, circuit breakers, switchgear, and substations.

Throughout this wide range of products, you can depend on Allis-Chalmers for equipment engineered to meet your exact needs.

CHALMERS

A-C ALLIS-CHALMERS

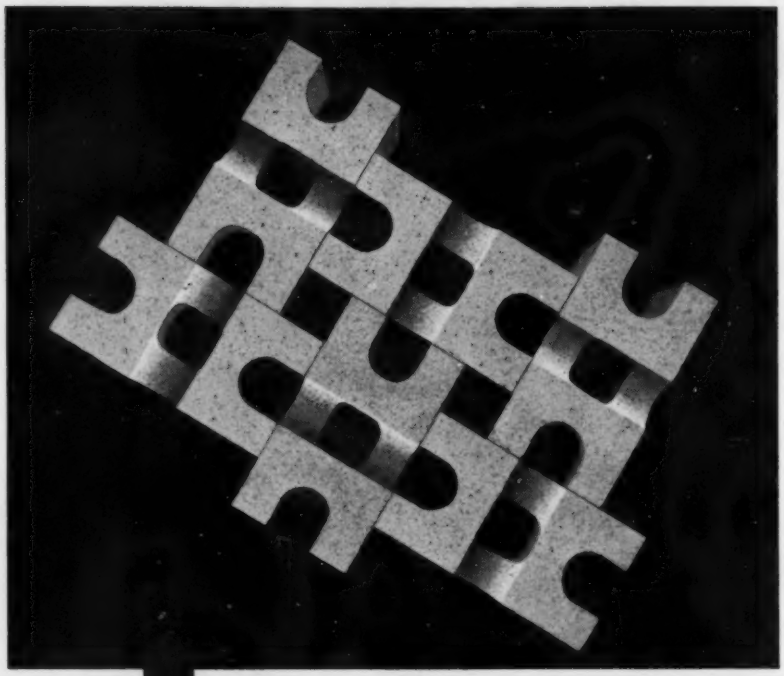
A-4907

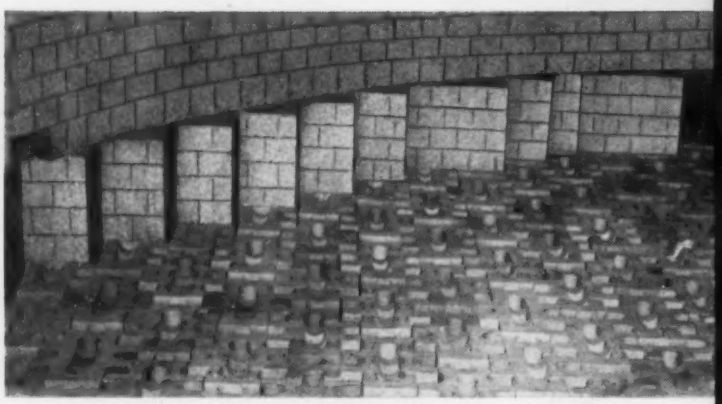
New design provides

25% to 50%

GREATER HEATING SURFACE

than ordinary basket weave checkers



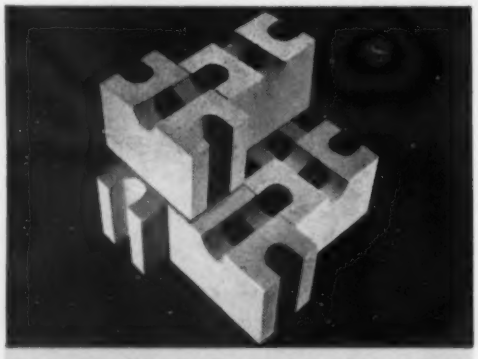


Tendency of checkers to twist in service is overcome by pilaster wall construction of the Bailey Hot Blast Stove.

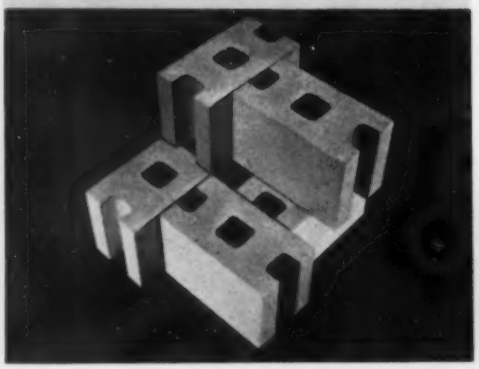
KENNEDY

BLAST FURNACE STOVE

CHECKERS



The regular Kennedy Checker (above) is of 3-hole design with unobstructed flue openings, 1¼" minimum wall thickness and a cross flue. It also can be furnished (below) without the cross flue feature.



This new 3-hole checker shape is laid in basket weave style to produce a solid 1¼" wall between each flue. This assures greatly increased heating surface without sacrificing the advantages of basket weave design.

The increased heating surface of the Kennedy Checker results in a correspondingly lower stack temperature. This makes possible the use of a modern steel bottom for supporting the checker system.

Write for Bulletin

WILLIAM M. **Bailey** COMPANY

ENGINEERS

LEADERSHIP THROUGH QUALITY

1221 BANKSVILLE ROAD PITTSBURGH 16, PA

Type 500 Goodman Continuous Coal Mining Machine in operation.

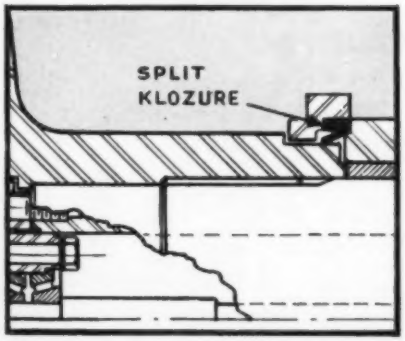
Garlock Split-KLOZURE Oil Seal—specifically designed for heavy equipment.

Goodman Mining Machines get positive bearing protection with KLOZURE* OIL SEALS!

The bearings on Goodman Mining Machines are subjected to the most severe service conditions—particularly coal dust and dampness. To provide positive protection for these costly bearings, Goodman engineers use dependable KLOZURE Oil Seals.

Garlock Split-KLOZURES, which can be installed around the shaft *without* dismantling the equipment, are used on the main bearing. Standard Model 53 Finger Spring KLOZURES (not illustrated) are used on the tractor roller bearings.

Let us show you how superior KLOZURE Oil Seals can solve your sealing problems. Just contact the Garlock office nearest you, or write for KLOZURE Catalog 10.



Cross section shows Garlock Split KLOZURE Seal as applied to the rotor assembly (main) bearing of Goodman's Type 401 Miner.

*Registered Trademark

THE GARLOCK PACKING COMPANY, PALMYRA, NEW YORK

Sales Offices and Warehouses: Baltimore, Birmingham, Boston, Buffalo, Chicago, Cincinnati, Cleveland, Denver, Detroit, Houston, Los Angeles, New Orleans, New York City, Palmyra (N.Y.), Philadelphia, Pittsburgh, Portland (Oregon), Salt Lake City, San Francisco, St. Louis, Seattle, Spokane, Tulsa.

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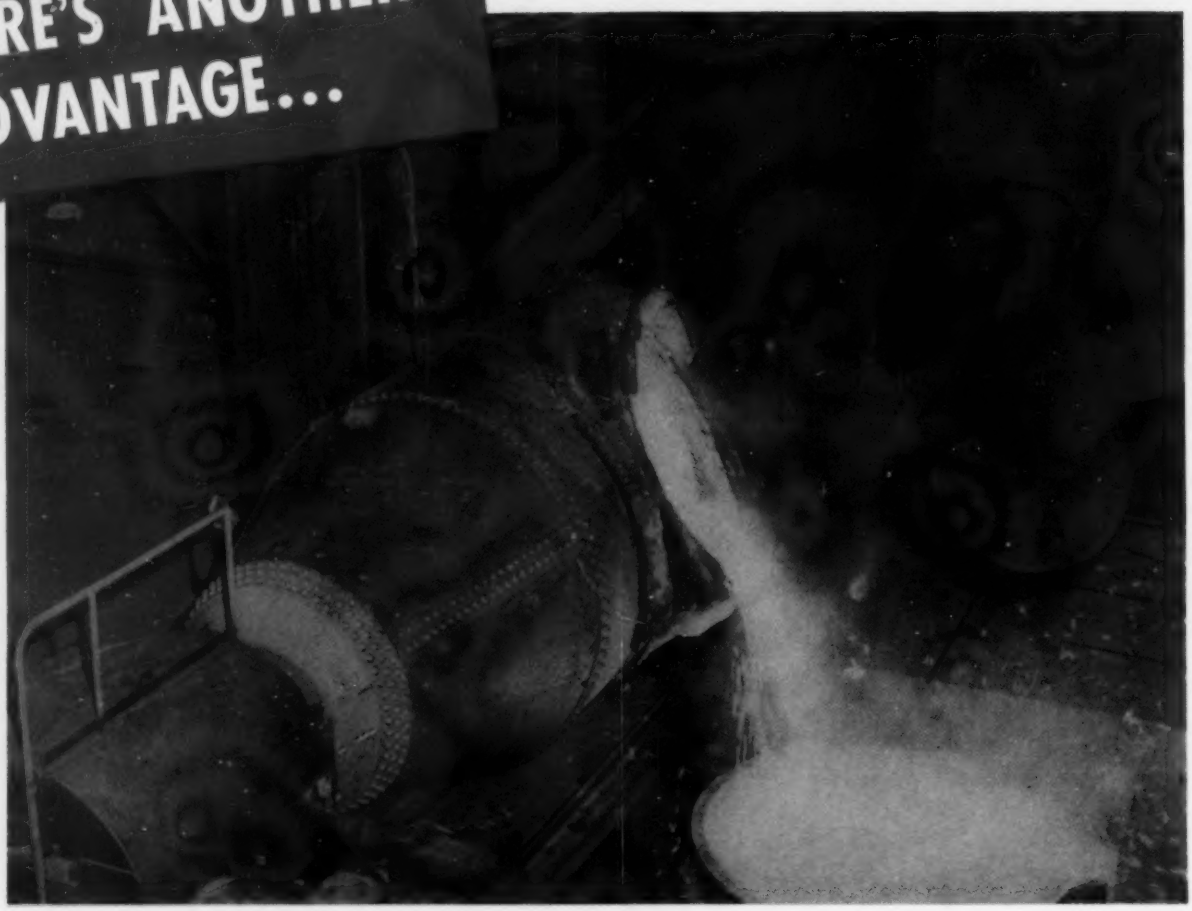
GARLOCK

HERE'S ANOTHER ADVANTAGE...



Treadwell hot metal cars eliminate the need for stationary mixers

Many mills, which have TREADWELL Mixer-type Hot Metal Cars, have become convinced that they do not need to use stationary mixers. Instead, they hold the iron in the car ladles until charging time.

Mills which follow this practice have found that it results in an average conservation of heat of the iron of about 150 degrees. Furthermore, they save the expense of operating the stationary mixer, which can be figured conservatively at about 15¢ per ton.

And, heat loss in delivering iron from mixer car to steel making furnace by transfer ladle is no greater than the loss when transferring from stationary mixer to furnace.

In short, by using mixer cars you improve the steel making practice and, at the same time, reduce your costs.

Elimination of stationary mixers is only one of the many *cost-cutting advantages* of TREADWELL Mixer-type Hot Metal Cars. For the full story, send for a copy of *new* bulletin No. 60. No cost or obligation.

M. H. TREADWELL COMPANY, INC.

140 Cedar Street, New York 6, N. Y.

1015 Farmers Bank Bldg., Pittsburgh 22, Pa.

208 So. LaSalle St., Chicago 4, Ill.

TREADWELL

TR-10

Mixer-type HOT METAL CARS

An Orchid to a Champion

45" Reversing Slabbing Mill which has broken all world records by rolling 214,842 net slab tons in one month.

designed and built by

United

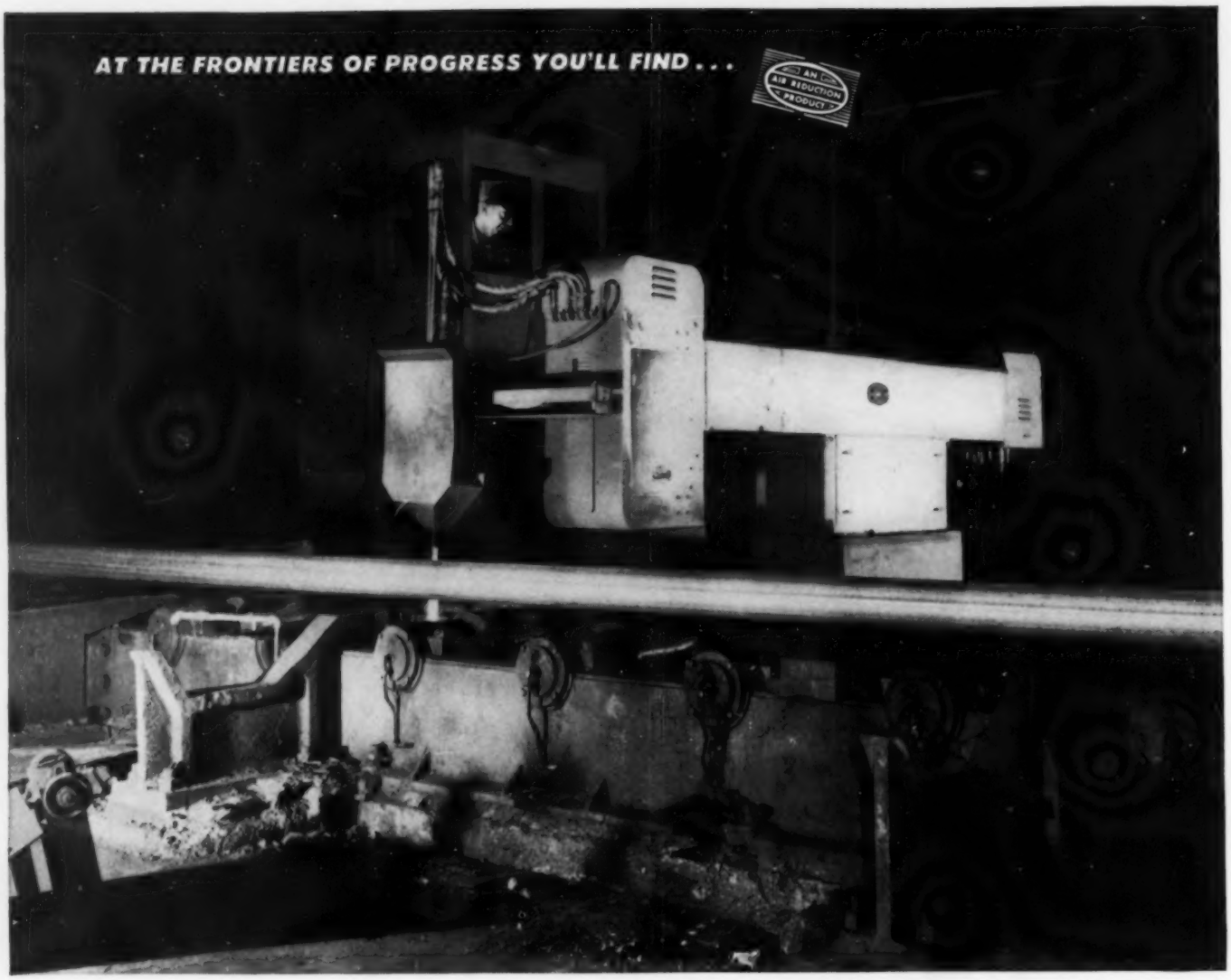
ENGINEERING AND FOUNDRY COMPANY

Pittsburgh, Pennsylvania

PLANTS AT PITTSBURGH • VANDERGRIFT • YOUNGSTOWN
CANTON • WILMINGTON (LOBDELL UNITED DIVISION)

SUBSIDIARIES: ADAMSON UNITED COMPANY, AKRON, OHIO
STEDMAN FOUNDRY AND MACHINE CO., INC., AURORA, INDIANA

Designers and Builders of Ferrous and Non-Ferrous Rolling Mills, Mill Rolls, Auxiliary Mill and Processing Equipment, Presses and other heavy machinery. Manufacturers of Iron, Nodular Iron and Steel Castings and Weldments.



This 80-inch stroke Airco hot cut-off unit makes consistent 17 second cuts on the 8½" rounds shown.

Airco hot bloom cut-off installation speeds mill production by remote control

The problem in a large Eastern steel mill was to cut long multiples of 8½" round blooms on the run-out table from a 30" mill without disturbing the rolling mill cycle. Only 25 seconds could be allowed for each cut.

On the recommendation of Airco Technical Service men a modern, custom-built Airco hot cut-off machine was installed. Torch movements are guided by remote control from an elevated station.

The equipment fulfilled every requirement. Trial cuts showed that it was possible to make consistent cuts in as little as 17 seconds, well within the mill cycle.

The speed, accuracy and convenience of this Airco unit is a result of Airco's long experience in oxyacetylene cutting applications in steel mills. Our Technical Sales representatives are ready to show you how it can speed and simplify your hot cutting techniques for maximum rolling mill capacity. For more information, write for Airco Bulletin ADR 97.

AIRCO®

AIR REDUCTION

60 East 42nd Street • New York 17, N. Y.

Divisions of Air Reduction Company, Incorporated, with offices and dealers in most principal cities
Air Reduction Sales Company
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Represented internationally by Airco Company International
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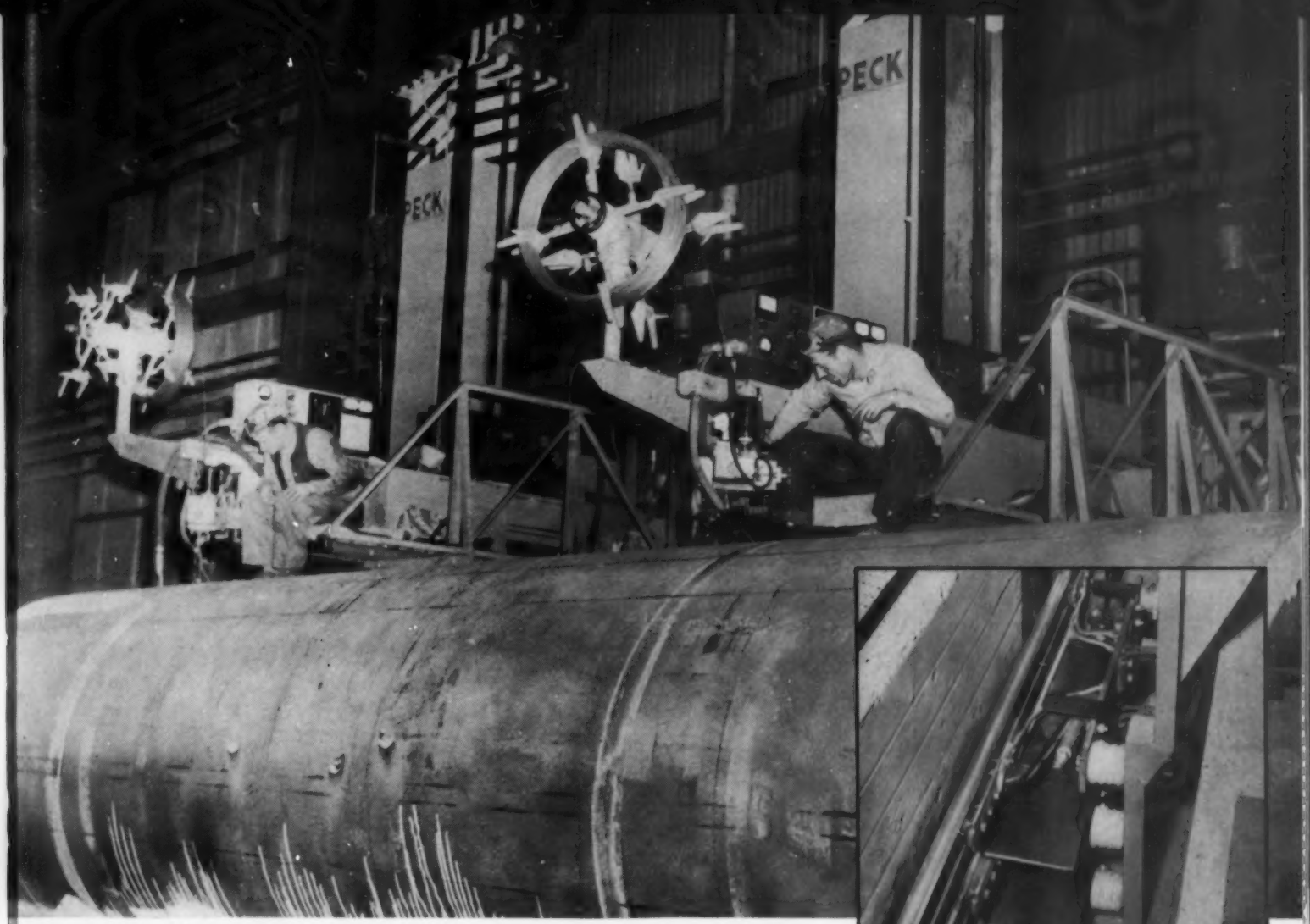
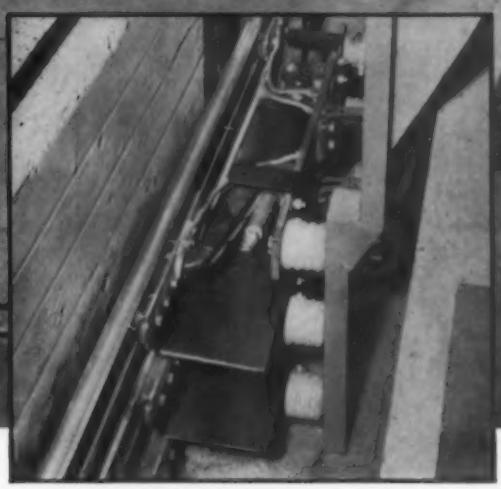
Products of the divisions of Air Reduction Company, Incorporated, include: **AIRCO** — industrial gases, welding and cutting equipment, and acetylenic chemicals • **PURECO** — carbon dioxide, liquid-solid ("DRY-ICE") • **OHIO** — medical gases and hospital equipment • **NATIONAL CARBIDE** — pipeline acetylene and calcium carbide • **COLTON** — polyvinyl acetates, alcohols, and other synthetic resins.



TANDEM WELDING HEADS in operation on heavy pressure vessel at Foster Wheeler Corporation.



VERTICALLY STACKED conductor rails with collectors running at right angles. This system operates at 675 amps. 440 volts.

KEYSTONE

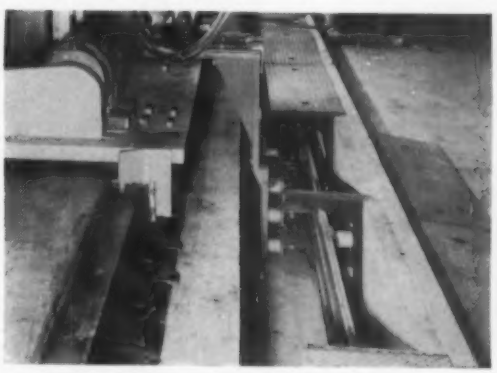
Clears the Deck for Action

Integrated Aluminum Conductor System Powers Automatic Welders Safely, Efficiently

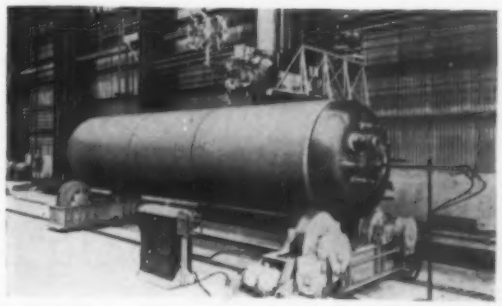
FOSTER WHEELER'S streamlined welding equipment gets much of its efficiency from the KEYSTONE Aluminum Conductor System that powers it. Hazardous cables are eliminated; this promotes safety and prevents interference which might cause hesitation or vibration—and thus an imperfect weld on the pressure vessel.

Welding generators may be completely mobile (as in this case) or stationary. Full welding current can be conducted where needed; conductor lengths have been installed up to 360 ft., can be longer. There's no limit as to length of rails or amperage handled with KEYSTONE Aluminum Conductor Systems.

IMPORTANT NOTE: This application is only one of many in all types of industries. It may suggest a power distribution method in your plant. Write for "Case Histories" on Keystone Aluminum Conductor Systems."



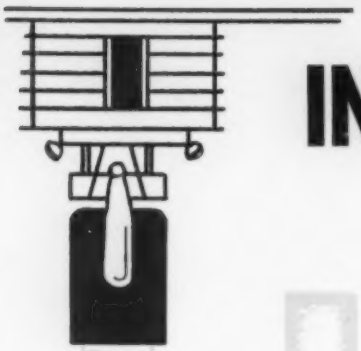
RECESSED POWER source with safety plates removed to show side mounted aluminum conductors and collectors.



ROTATING CRADLE and moving welder permits horizontal and circular welding. Behind cradle is KEYSTONE Aluminum Conductor System.

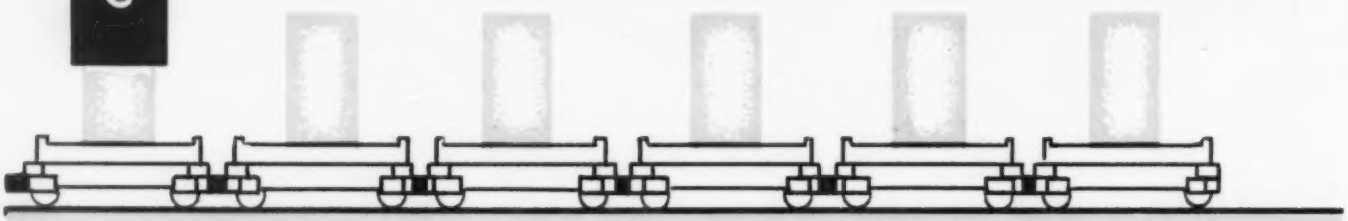
KEYSTONE **ELECTRIC SERVICE MANUFACTURING CO.**

Philadelphia 32, Pennsylvania



INCREASE INGOT OUTPUT

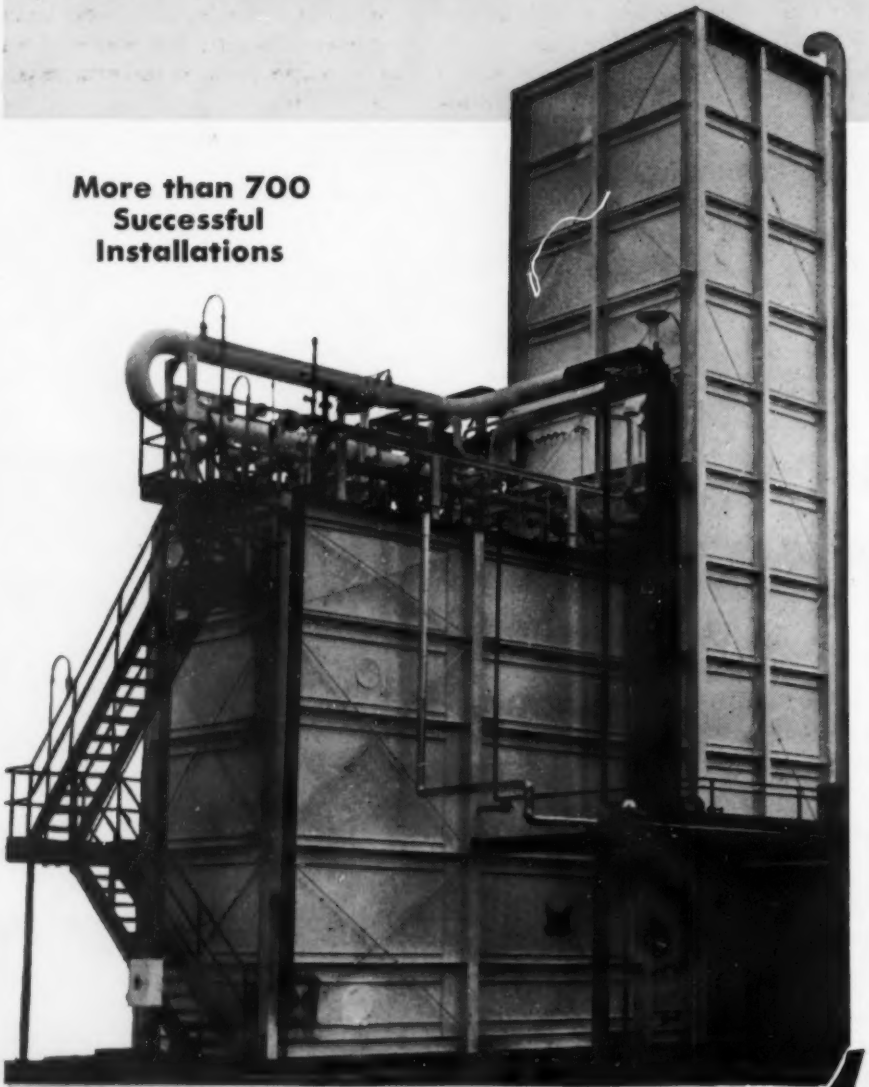
without capital investment



with

"ON-LOCATION" OXYGEN GENERATORS

More than 700 Successful Installations



Full utilization of oxygen in blast furnaces, open hearths and steel converters offers the Steel Industry the most economical means of increasing ingot output. And, of course, a captive generator is essential for the use of oxygen in adequate quantity.

We will furnish and install an "On-Location" oxygen and/or nitrogen generating station to suit your present and expanding oxygen requirements —on a lease basis (you can operate and maintain or Air Products will operate and maintain), with price guaranteed at all levels of consumption, *without capital investment by you.*

We design and manufacture:
Generators for unlimited quantities of oxygen and nitrogen regardless of size, purity or cycle.

If you will send us details regarding your requirements, we will give you a close estimate of the savings you can expect with Air Products "On-Location" Oxygen and/or Nitrogen Generators installed at your plant.

LOW COST OXYGEN...NITROGEN

Air Products
INCORPORATED
Dept. P, Box 538, Allentown, Pa.

By MELVIN NORD, Patent Attorney, Detroit, Mich.

Patent Reviews

. . . . copies of patents may be obtained from the Commissioner of Patents, Washington 25, D. C. at 25 cents . . . . patents reviewed cover period October 25, 1955 through December 8, 1955 . . . .

BLAST FURNACE PRESSURE REGULATOR

▲ U.S. 2,721,065, issued Oct. 18, 1955 to Walter J. Ingram, describes an improved system and apparatus for pressurized operation of blast furnaces.

In Figure 1, A designates a blast furnace. Gases leave the furnace through a dust catcher D, a primary gas washer E, and secondary gas washer and pressure regulator F, and leave through pipe C.

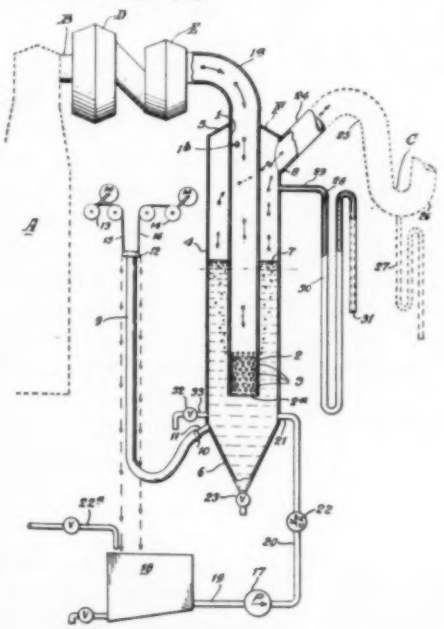


Figure 1

Gas flowing through the inner pipe 1 of the pressure regulator escapes through openings 3. These openings restrict the flow of gas and build up back pressure in the blast furnace. A gas outlet port 1b is provided at the top of the pipe 1, permitting escape of gas when all the openings 3 are closed by a level of water 7 surrounding pipe 1. By raising or lowering the head of water in the outer shell 4, the gas pressure is maintained at any desired level. The water level is regulated by the height of the flexible conduit 9. A pump 17 supplies water continuously to the shell 4, and it continuously overflows back to the reservoir 18.

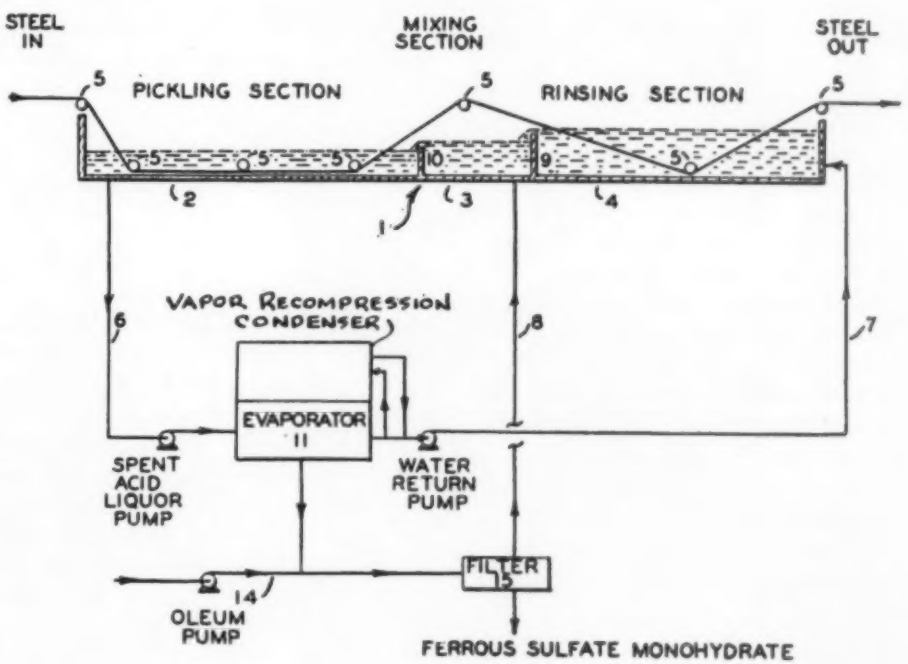
The numeral 28 designates a water seal, preventing escape of gas while providing a maximum water level for the apparatus.

SPENT PICKLE LIQUOR REGENERATION

U.S. 2,721,562, issued Oct. 25, 1955 to Robert L. Irvine and assigned to Belle Fons Chemical Corp., describes a process and apparatus for reclaiming spent pickle liquor in a continuous manner, whereby the waste of unreacted sulphuric acid and iron sulphate are avoided.

In Figure 2, numeral 1 designates an elongated tank having a pickling section 2, an acid diluting section 3, and a water rinsing section 4. A strip of steel is passed by driven rollers 5, through the pickling section 2, above the acid diluting section 3, and through the water rinsing section 4. Through the pickling section 2 is flowed, countercurrently to the direction of the steel, an aqueous solution

Figure 2



of sulphuric acid. In the course of passing through the acid solution of section 2, the iron oxide scale on the steel sheet reacts with the sulphuric acid to form iron sulphate, thus cleaning the surface of the steel. Spent pickle liquor from the pickling section 2, containing iron sulphate and dilute sulphuric acid, is continuously withdrawn by a line 6 at the end of section 2 for passage through spent acid recovery equipment. Fresh water from the acid recovery equipment is continuously introduced to the rinsing section 4 by a line 7. The acid-washed steel strip is passed through the rinse water of section 4 to remove adhering acid which would tend to corrode the steel if left on it.

A continuous reconcentration of the acid in section 2 must be carried on to compensate for the continuous loss in acid strength due to the reaction forming iron sulphate. The reconcentration of the acid is accomplished by introducing concentrated sulphuric acid from the spent acid recovery equipment via line 8 into the diluting section 3. Section 3 is separated from rinsing section 4 by a weir 9 and from pickling section by a weir 10. The water in the rinsing section 4, being continuously introduced by line 7, continuously overflows the weir 9 into section 3. In section 3, a mixing of water flowing from section 4 and acid from line 8 takes place.

Spent acid from the end of section 2 is continuously introduced by line 6 into the acid recovery equipment. The spent acid passes first into an evaporator 11, in which the spent acid is heated to drive off water and concentrate the acid and the iron salts of the spent solution. The degree of concentration in evaporator 11 is moderate and insufficient to cause precipitation of much ferrous sulphate. The partially reconcentrated acid solution is withdrawn from the bottom of evaporator 11 and is mixed with make-up acid in the form of oleum or concentrated sulphuric acid introduced via line 14. Makeup acid is added in an amount sufficient to cause precipitation of substantially all of the ferrous sulphate carried by the acid solution. Following the addition of make-up acid, the reconcentrated solution is passed through the continuous filter 15, in which precipitated ferrous sulphate is removed. The acid filtrate then passes via line 8 into acid diluting section 3, as previously explained.

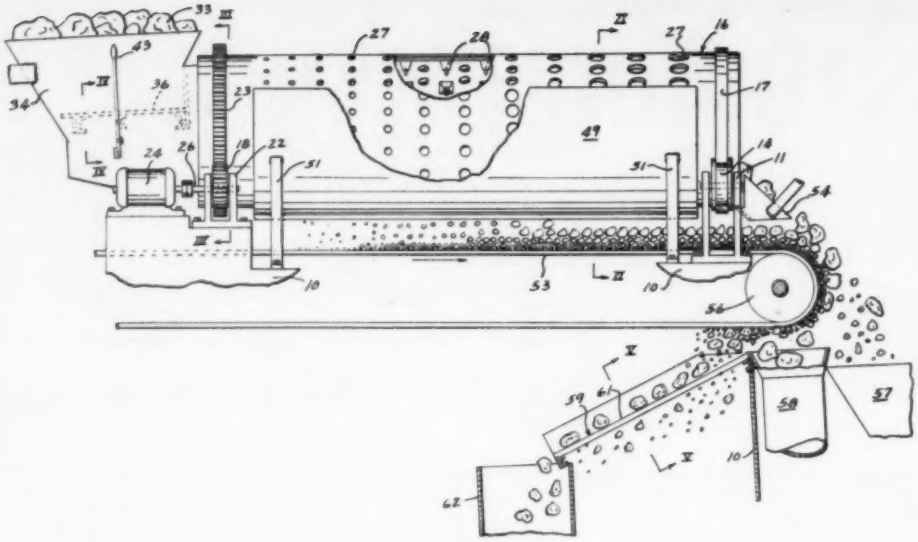


Figure 3

APPARATUS FOR SEPARATING STEEL FROM SLAG

U.S. 2,721,035, issued Oct. 18, 1955 to Frank E. Lankford and John L. Glasser, describes an apparatus for separation of chunks of steel from slag recovered in an open hearth furnace.

As shown in Figures 3 and 4, the slag and steel in the form of large masses 33 is introduced into the feed hopper 34. The smaller masses fall through the grate 36 into the cylinder 16 where the smaller sizes pass through the perforations 27 and fall into the shell 49, then through the opening 52 onto the conveyor 53. The larger chunks of the material 33 remain in the feed hopper until the operating handle 43 is moved to open the dump grate 36. As the cylinder 16 is rotated, the large chunks 33 are tumbled in intimate contact with each other inside the cylinder thus causing the slag to be broken loose from the steel. This action is aided by the breaker teeth 31 which engage the chunks as they tumble within the cylinder 16. The cylinder 16 is slightly tilted to cause the material to move toward the delivery end of the apparatus. As the cylinder rotates, small particles of slag and steel broken from the chunks of material pass through the perforations 27 and through the openings 52 onto the belt conveyor 53. The larger masses of material continue their travel through the cylinder 16 and are discharged through the chute 54 onto the discharge end of the belt conveyor 53. The non-magnetic chunks of material do not adhere to the belt conveyor as they pass over

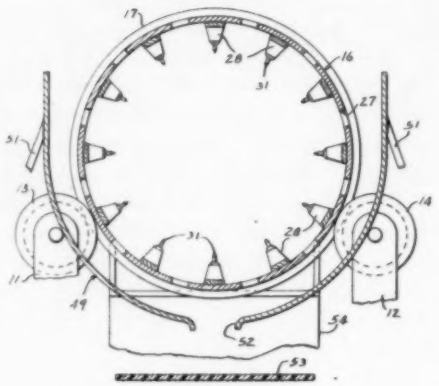


Figure 4

the magnetic pulley 56 but fall into the receptacle 57. The larger magnetic pieces pass around the pulley 56 and fall into the receptacle 58. The medium and smaller size pieces of steel are retained on the belt conveyor 53 until they pass out of the magnetic field where they fall onto the grizzly 59. The smaller pieces of steel pass between the bars 61 of the grizzly and are collected in a suitable container while the medium size pieces of steel are discharged into the receptacle 62.

DRYING METAL SCRAP

U.S. 2,720,710, issued Oct. 18, 1955 to John L. Erisman and assigned to Link-Belt Co., describes a method and apparatus for drying and removing cutting oils from metal scrap, such as chips, filings and turnings.

BLAST FURNACE COOLING PLATE HOLDER

U.S. 2,722,412, issued Nov. 1, 1955 to Oscar B. Anderson and Banks I. Jacob, provides an assembly for

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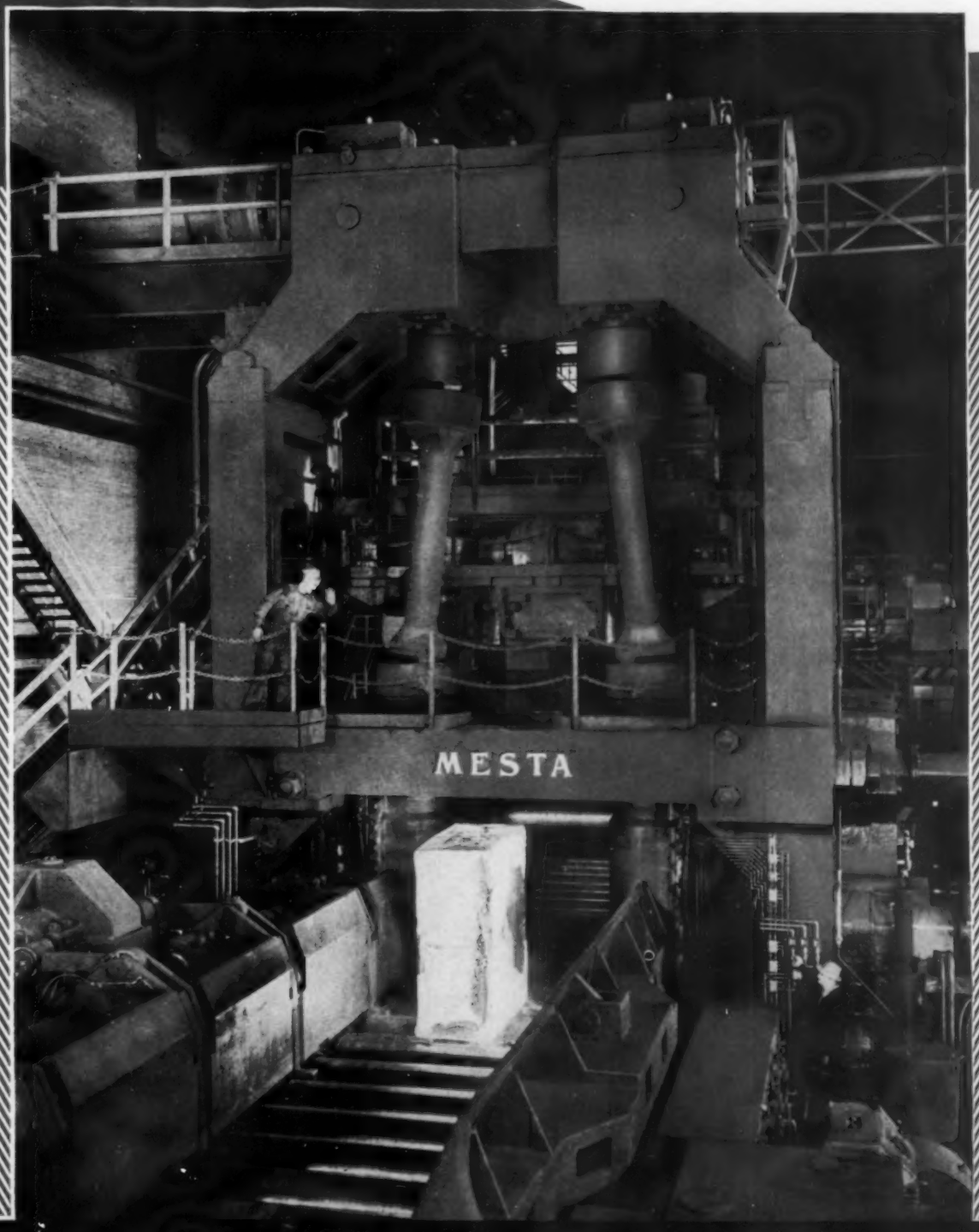

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mounting and holding cooling plates in blast furnaces, which can be used at different furnace levels, which provides an adequate seal against leaks, and which permits inspection of the cooling plate and its water circulating connections.

Figure 5 shows a brickwork lining having cooling plate embedded in it. Figure 6 shows one of the assemblies, and Figure 7 is a sectional view of one of the cooling plates.

At vertically and circumferentially spaced intervals, staggered tiers of water-cooled plates 5 are embedded in the brickwork of the stack lining 1 to protect it from overheating. Opposite each of the plates 5, the shell 3 is provided with an opening. Each of the cooling plates 5 is a hollow casting, preferably copper, having a partition 7 separating it into two chambers through which cooling water may be circulated. Its outer end 10 is provided with water inlet and outlet openings 11 and 12 through which water may be circulated through the chambers in its interior.

The plates 5 are installed with their inner ends 9 uniformly spaced from the inside surface 13 of the brickwork lining 1. The uniform spacing of the ends 9 with respect to the surface 13 is essential in order to assure uniform wear of the lining after the furnace is put into operation. When a furnace is first placed in operation, the surface 13 wears rapidly until a new brickline is established and which will have an undulating surface, the high points of which are directly opposite the ends 9 of the cooling plates. Since the shell has the shape of a truncated cone and therefore a fixed slope, while the surface 13 has a different slope designed to facilitate downward movement of the furnace charge, the spacing of the surface 13 and shell 3 varies at different furnace levels. Since the plates 5 have the same length and their inner ends 9 are spaced uniformly relative to the surface 13, the plate outer ends 10 are spaced at different distances with respect to the shell 3.

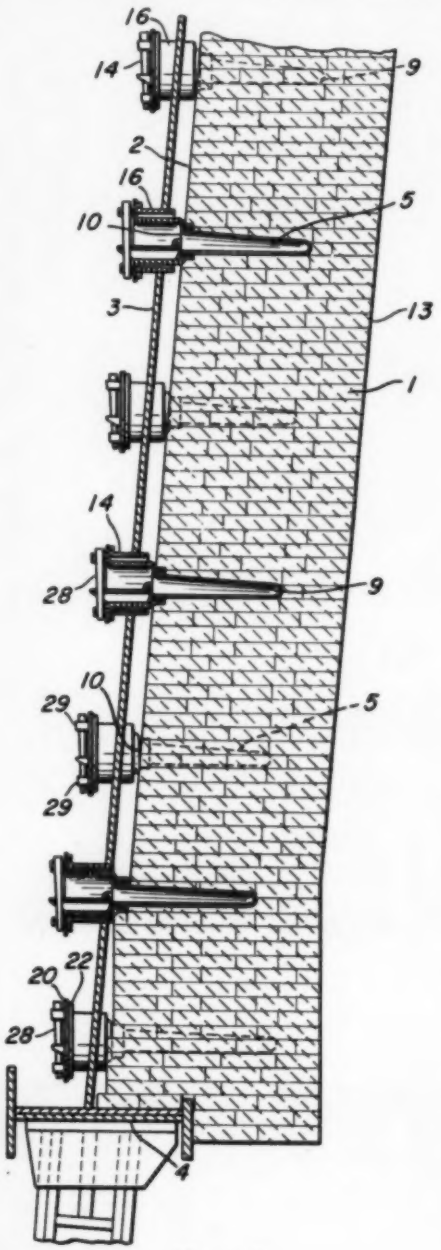


Figure 5

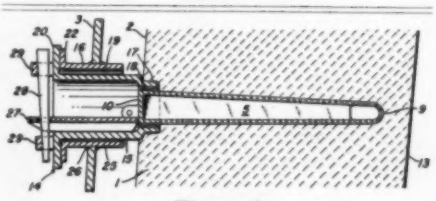


Figure 6

Figure 7

SELF-CENTERING ROLL

U.S. 2,720,692, issued Oct. 18, 1955 to Edwin T. Lorig and assigned to United States Steel Corp., describes a self-centering roll.

As shown in Figure 8, numeral 2 indicates a rotable roll over which a strip or strip like material S passes. The roll consists of a shaft 4 having discs 6 mounted on it. The shaft 4 is supported by means of bearings 8 arranged in housing 10. If it is desired to drive the roll an extension 12 can be provided at one end of the shaft 4. The main portion 14 of the shaft between the bearings 8 is square

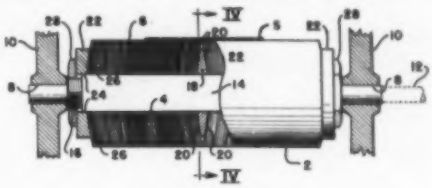
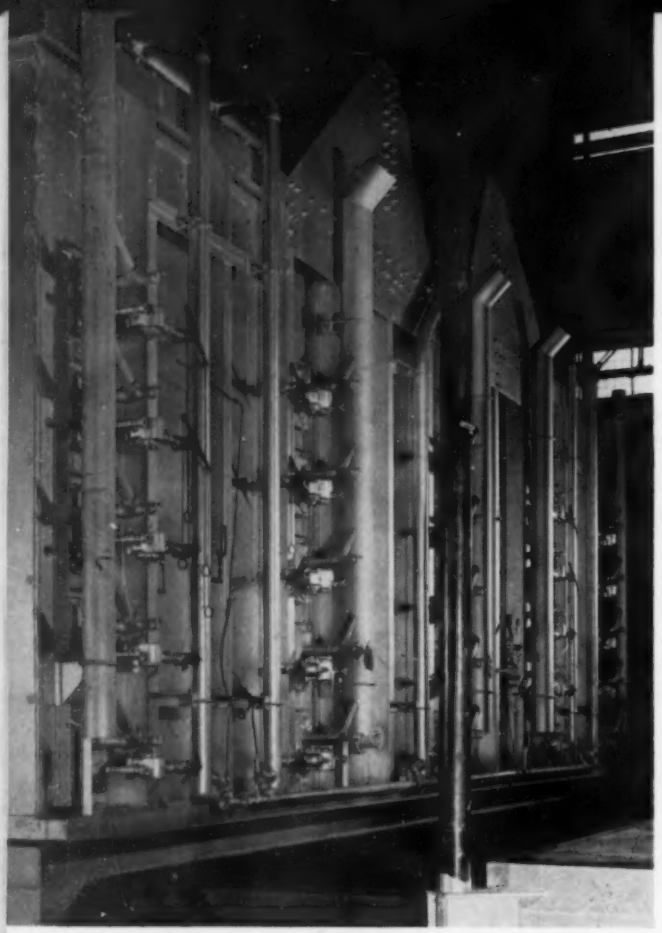


Figure 8

in cross section. Considerable force (approximately thirteen tons) is necessary to position the discs on the shaft in their final position. The holes in the discs are smaller than the outside diameter of the square portion 14, thus insuring that the discs will rotate in unison with each other and with the shaft 4. After the discs are assembled on the shaft, the outside surface of the roll 2 is ground to the desired shape which may be cylindrical or with a crown in the center. The support provided by the surfaces 20 and 26 insure that the discs 6 will always move in the desired direction to center an object passing over the roll.

OTHER PATENTS OF INTEREST TO THE IRON AND STEEL ENGINEER

Patent No.	Date	Subject	Inventor or Assignee
2,721,070	10/18/55	Two pass gas circulating separator	United States Steel Corp.
2,721,073	10/18/55	Sealed cupolas and charging apparatus	Modern Equipment Co.
2,721,573	10/25/55	Device for supplying flushing liquid to the collecting mains of coke ovens	Koppers Co., Inc.
2,721,734	10/25/55	Multiple unit annealing furnaces	Heinrich Grunewald et al
2,721,793	10/25/55	Method of beneficiating ferrotitani-ferous ores	American Cyanamid Co.
2,721,948	10/25/55	Automatic voltage and electrode control for electric arc furnaces	Ohio Ferro-Alloys Corp.
2,722,174	11/ 1/55	Hydraulic press	Hydropress, Inc.
2,722,413	11/ 1/55	Apparatus for removing and replacing the cover of a furnace	Westofen G.m.b.H.
2,722,589	11/ 1/55	Method and apparatus for uniformly heating and intermittently moving metallic strip	The Ohio Crankshaft Co.
2,723,086	11/ 8/55	Coiler drum for strip material	Davy and United Engineering Co., Ltd.



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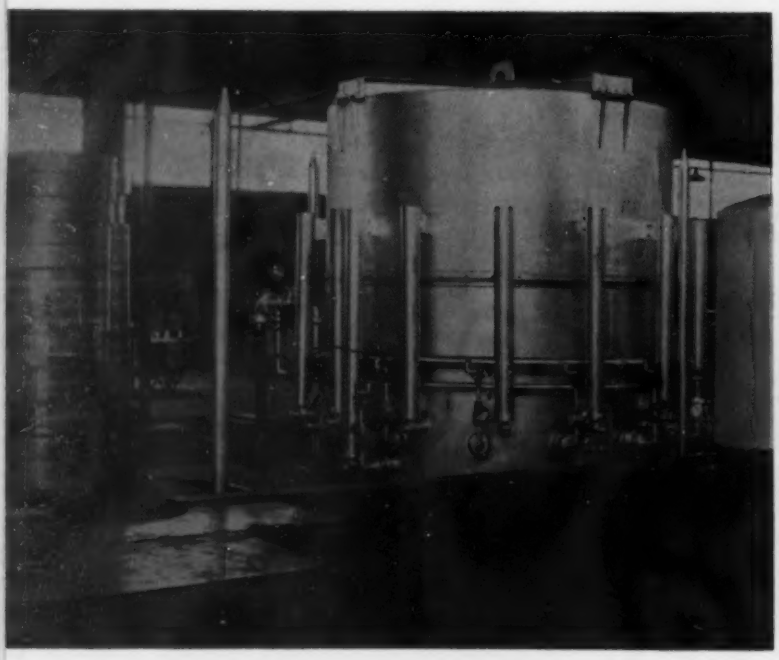

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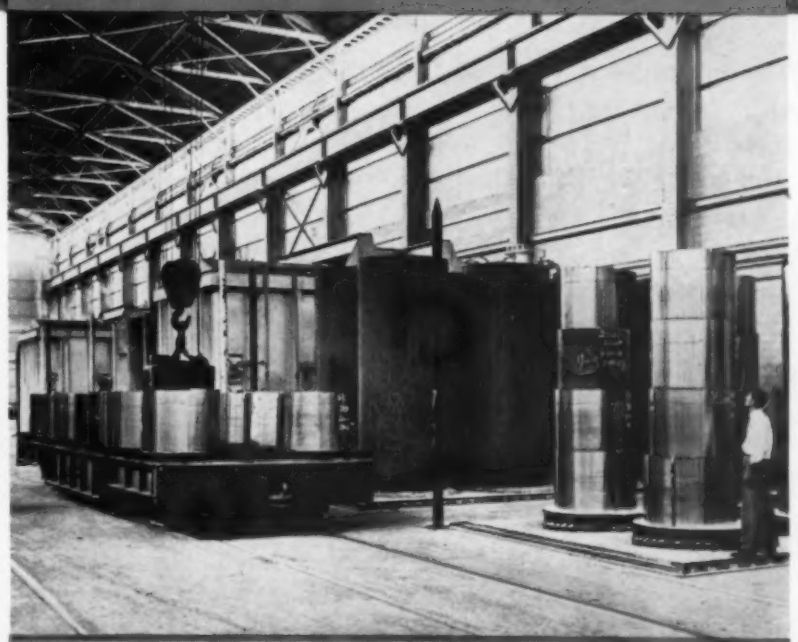

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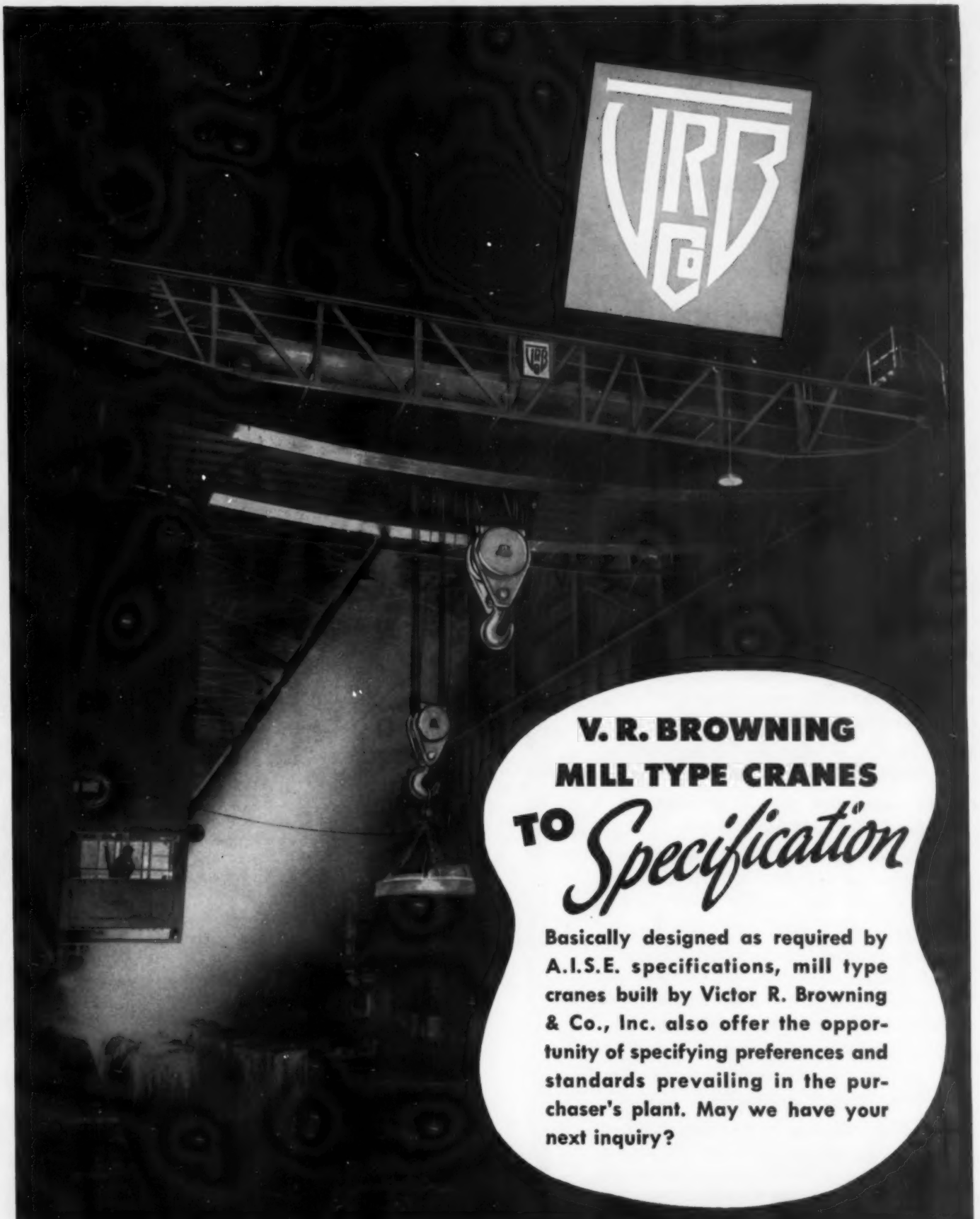
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Frequent Instrument Check-ups Prevent Emergencies

The economical way to protect your plant's investment in instrumentation is a Honeywell Periodic Service Plan. Under this plan, a Honeywell service specialist comes to your plant at regular intervals to—

— Check your Brown instruments and calibrate them against accurate laboratory standards.

— Inspect all moving parts, clean and lubricate them, and replace where necessary.

You get this kind of service performed regularly for your office equipment such as typewriters and calculating machines . . . for your automobile . . . and even for yourself by periodic check-ups by your doctor. You've learned that the ounce of prevention is a good investment. Well, the same philosophy applies to instruments, too. Keeping them in good condition is far more economical than waiting for emergencies to throw production schedules into a tailspin.

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Periodic examination and adjustment by a factory-trained service engineer.

Automatic attention. Calls are made on a schedule that fits your own requirements . . . at a cost substantially lower than an equivalent emergency service call.

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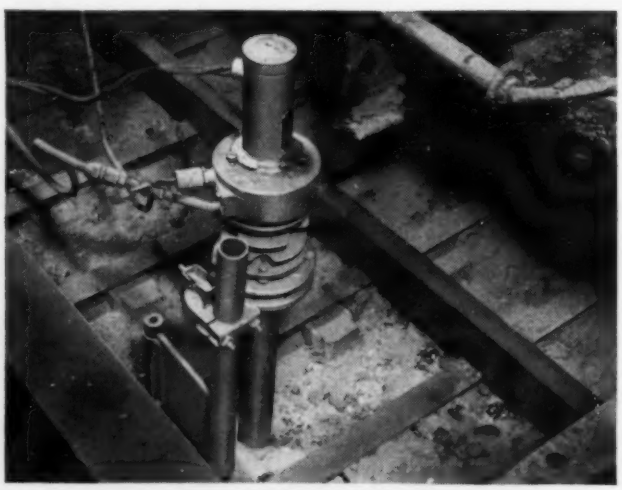
Increased plant efficiency. Greater reliability of operation builds confidence of plant personnel in their equipment.

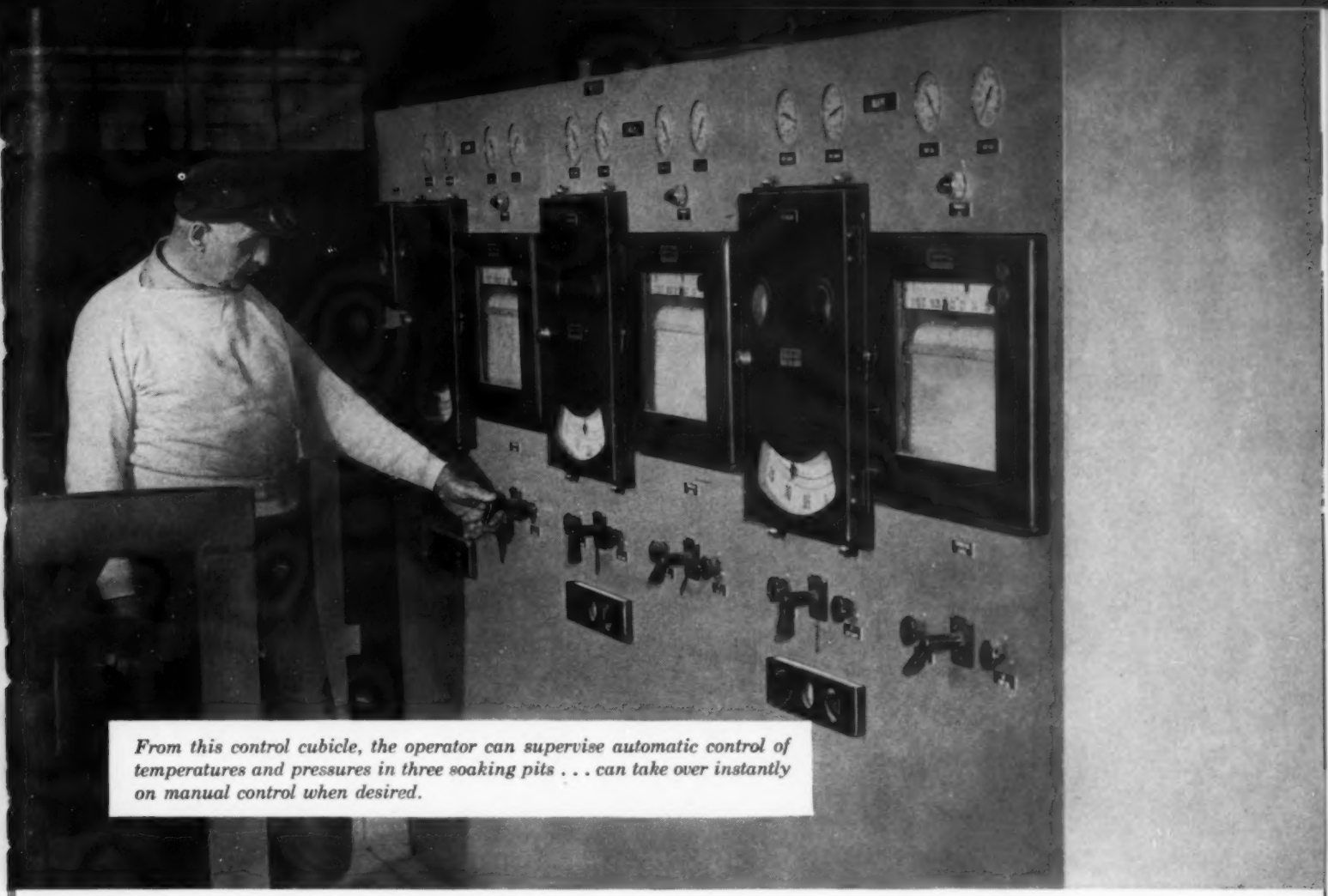
At any time, of course, you can count on prompt emergency service from any one of the more than 100 Honeywell service centers spotted throughout the United States and Canada.

The Plan is extremely simple. It costs remarkably little, and can pay real dividends in protection of your production schedules and your instrument investment. For details about how it can be applied to your own plant, call your local Honeywell office.

Brown controls for Lukens pits boost quality and



Soaking pit temperatures are detected by a ***Radiamatic*** *unit installed in the pit cover.*



From this control cubicle, the operator can supervise automatic control of temperatures and pressures in three soaking pits . . . can take over instantly on manual control when desired.

efficiency of steel production

MODERNIZING soaking pit operation by conversion from manual to fully automatic control . . . using Brown instrumentation . . . is helping Lukens Steel Company to make improvements in operation. Two regenerative soaking pits, each containing three holes, are now equipped with control centers from which temperature, draft and reversal timing are automatically regulated.

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Instrumentation for each pit includes an *ElectroniK* temperature controller, working with a *Radiamatic* element installed in the cover. A Brown Furnace Pressure Controller regulates draft to maintain the desired heat distribution and flow of combustion gases. At the turn of a switch, the operator can take over on manual control instantly, for emergency or start-up. Furnace reversal, normally automatically timed, can also be handled manually.

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● **REFERENCE DATA:** Write for Catalog 1531, "*ElectroniK* Controllers".

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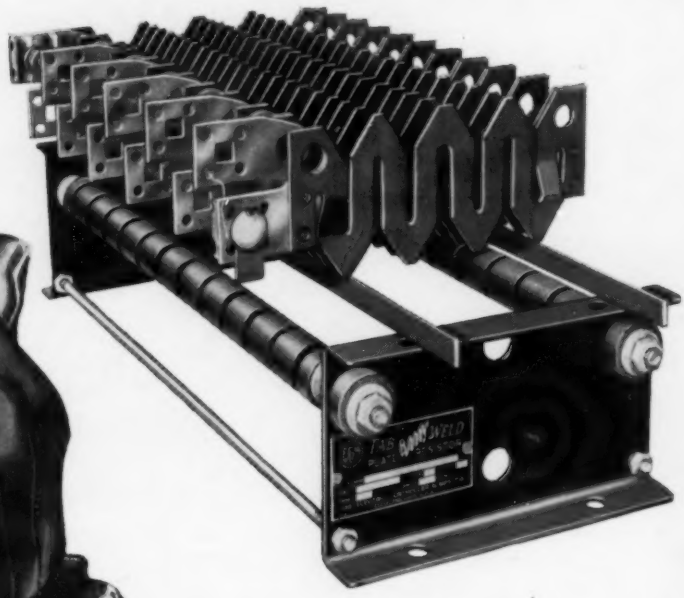

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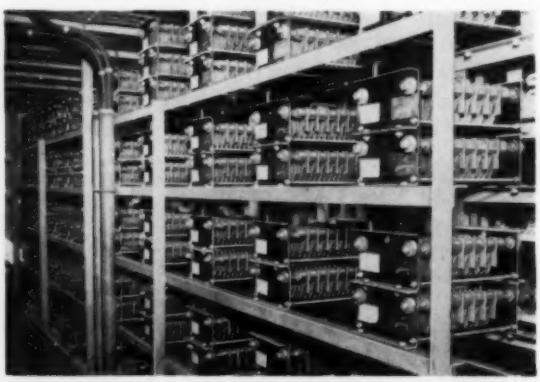
Look into EC&M Bulletin 942 TAB-WELD Resistors for economy in selection and performance. This one source meets all conditions efficiently.



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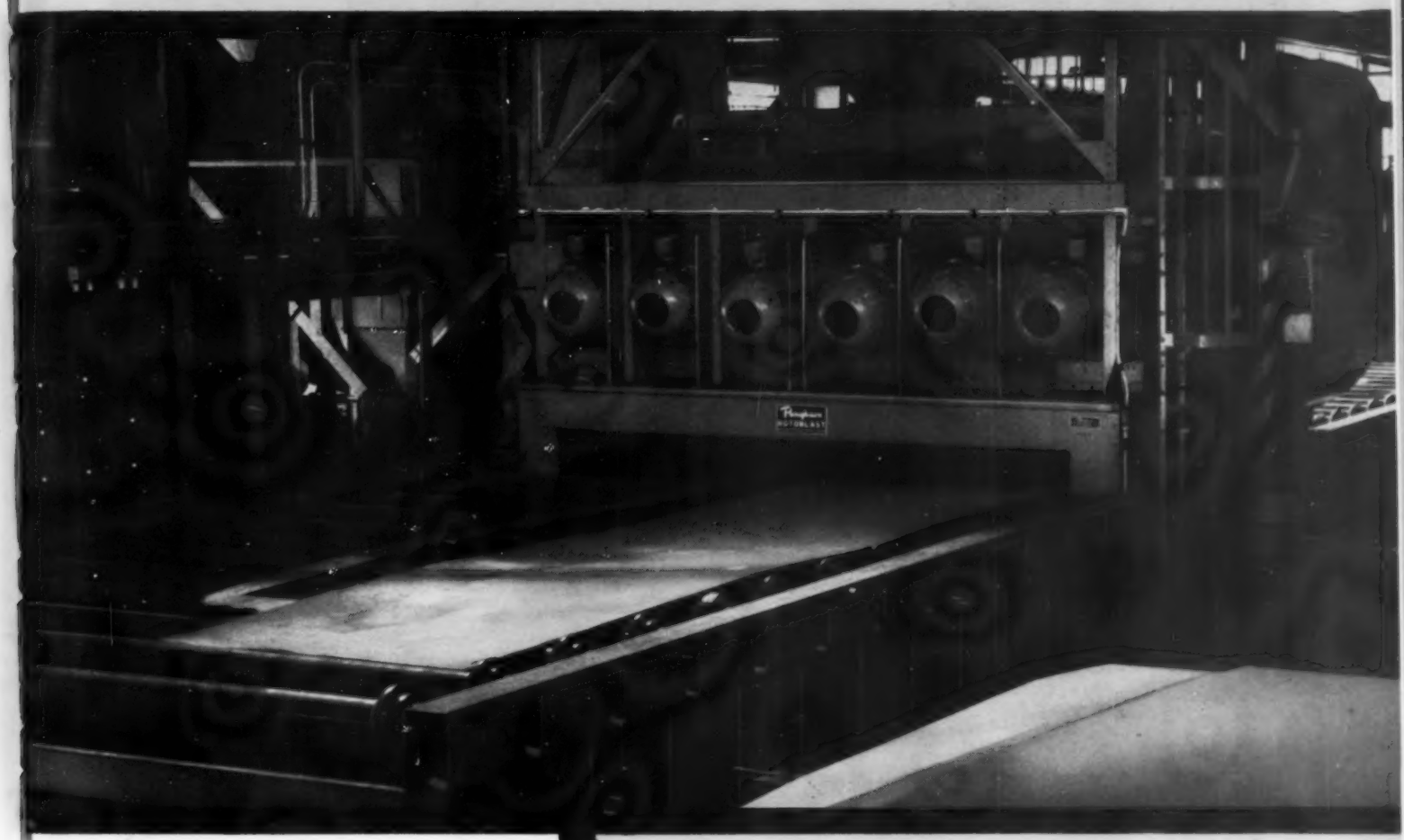

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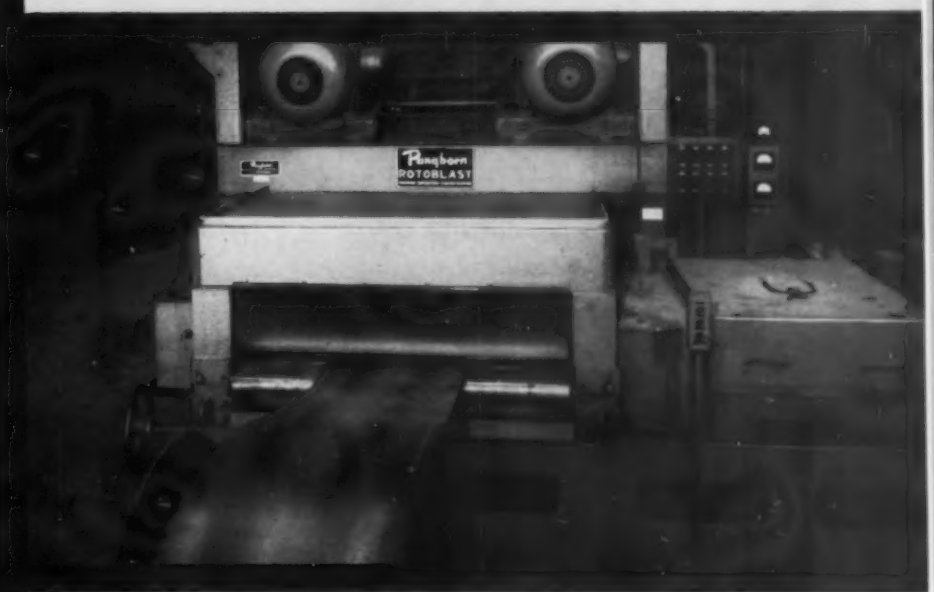

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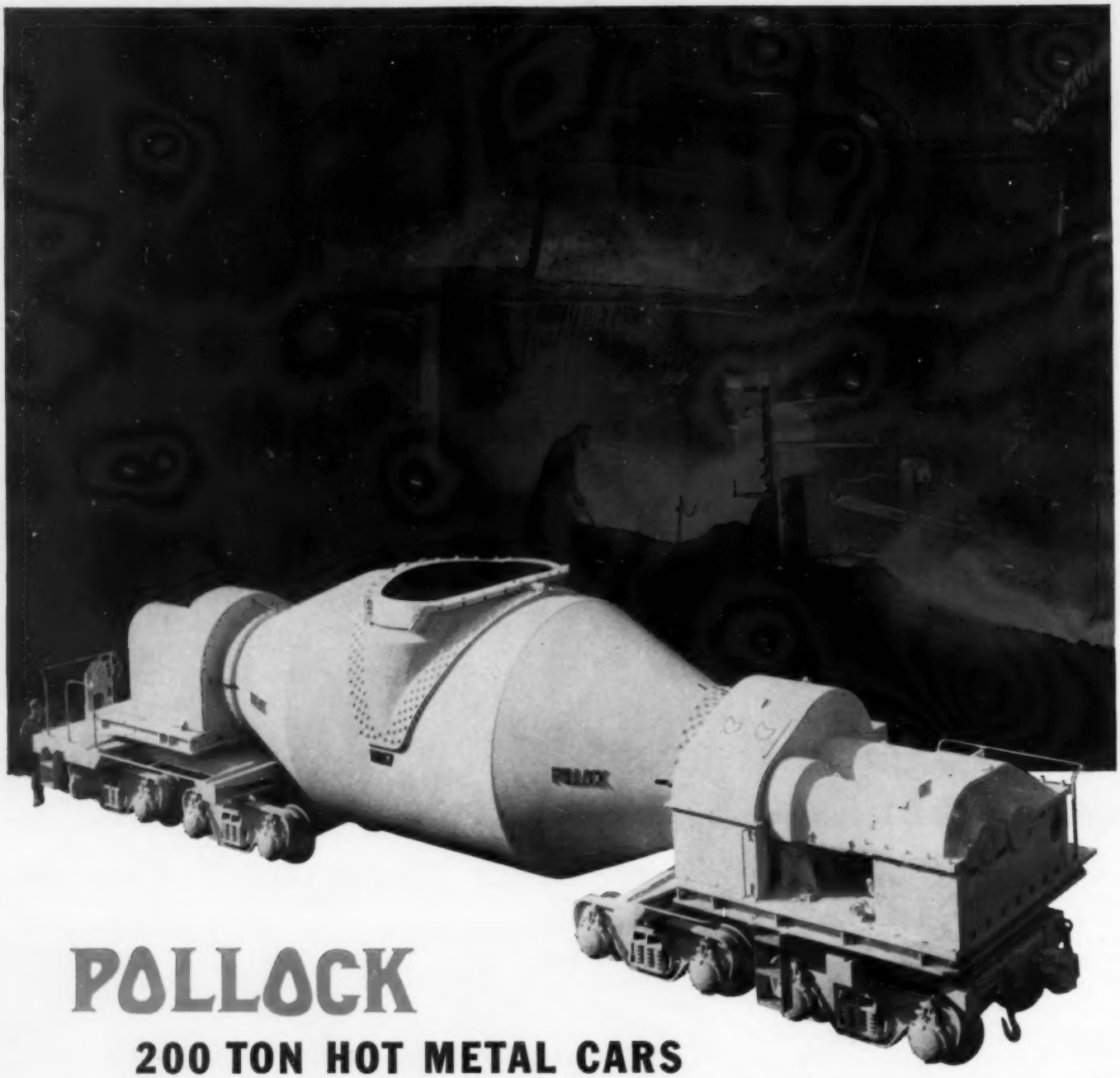

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This car was designed and built by Pollock to meet the particular requirements of the Fairless blast furnace and steel plant.

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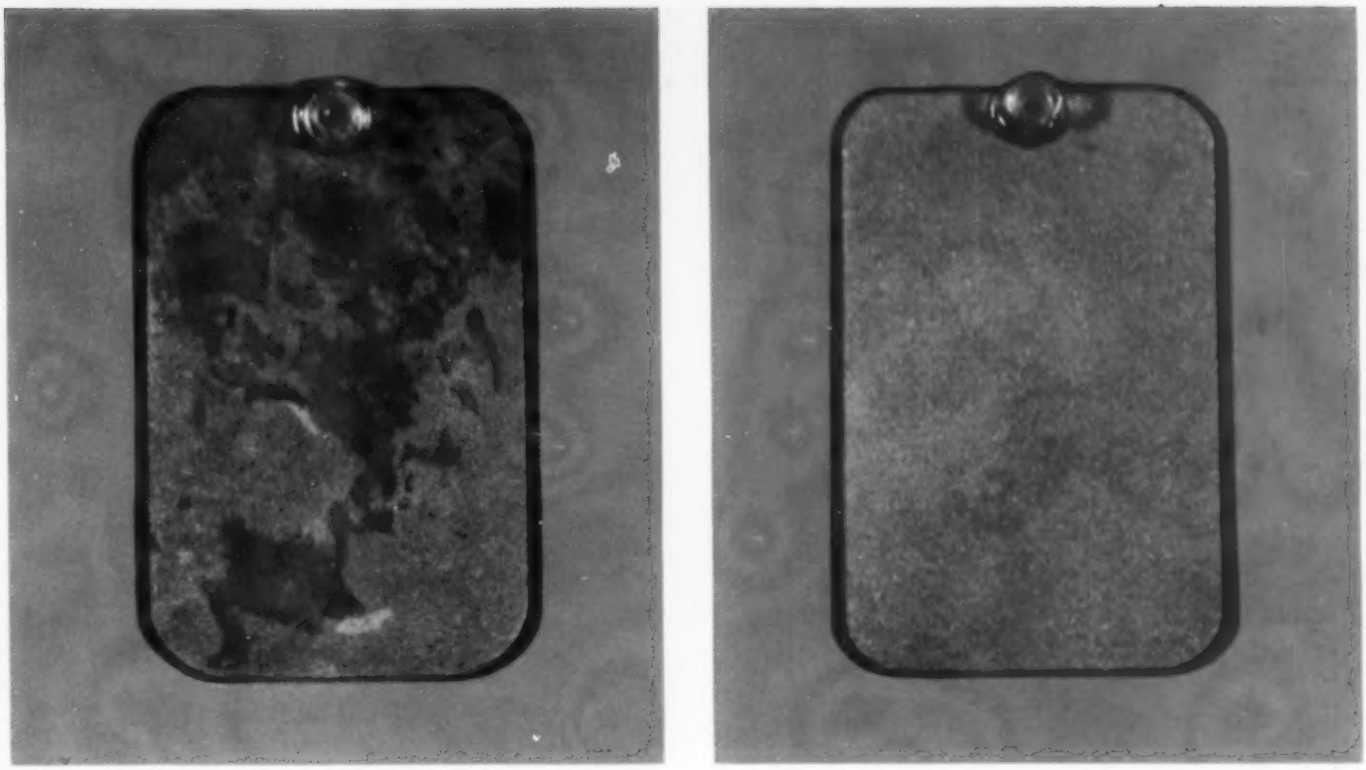

Efficiency of New Sun Rust-Preventive Grease is shown by accelerated test. Rusted test plate (left) was coated with ordinary grease. The large amount of rust was formed during a 48 hour immersion in synthetic sea water. Plate (right) protected by new Sun rust-preventive grease is wholly rust free after 48 hours.

NEW GREASES PREVENT HARMFUL RUST

Sun rust-preventive greases give improved lubrication ...protect against wet or humid operating conditions

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Water contamination in grease-lubricated parts reduces lubricant life, promotes corrosive wear, and may lead to failure of bearing surfaces.

Sun Oil's new rust-preventive greases are specially fortified to overcome this problem. They give extra protection against both direct water contamination and indirect water contamination caused by high humidity and condensation during overnight and week-end shut downs.

Available at the price of ordinary greases, new Sun rust-preventive greases come in many different grades. For complete information, see your Sun representative, or write for Sun Technical Bulletin 38. Address SUN OIL COMPANY, Philadelphia 3, Pa., Dept. GI-1.

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- **Save storing and handling special-purpose greases**

Sun Oil Company's new greases are fortified to protect against rust. Lubricity is improved and wear is reduced because grease-lubricated parts are now protected at all times against rust and corrosion caused by condensation and process water.

The effective life of these new rust-preventive greases is approximately twice that of conventional greases operating under wet conditions. And, their extra protection against moisture permits their use as a rust-proofing medium for shop storage of tools and parts.

Competitively priced with ordinary greases, these new greases can be applied by any conventional method... brush, swab, pressure gun, or through central pressure systems.

Because of their improved quality, these new Sun greases will now perform 90% of all grease lubrication jobs. You reduce grease inventories ...lessen the risk of using the wrong grease... simplify your handling problems.

For complete information, see your Sun representative or write SUN OIL COMPANY, Philadelphia 3, Pa., Dept. GI-2.

SUNOCO®

INDUSTRIAL PRODUCTS DEPARTMENT

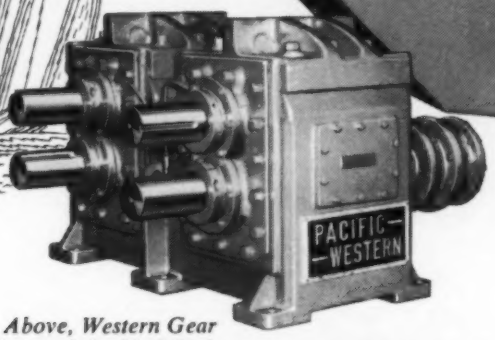
SUN OIL COMPANY, PHILADELPHIA 3, PA.

IN CANADA: SUN OIL COMPANY, LTD., TORONTO AND MONTREAL

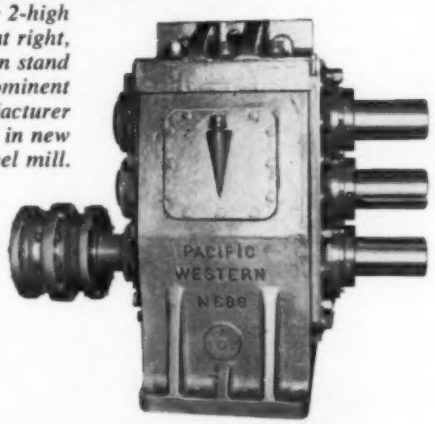
WESTERN GEAR rolling mill drives

...rugged as Gibraltar!

Western Gear 2500 HP Model S-87-MS speed reducer 5.7:1 ratio utilizing double helical staggered tooth gears.



Above, Western Gear designed double 2-high pinion stand, and at right, single 3-high pinion stand manufactured for prominent mill equipment manufacturer for installation in new Italian steel mill.



Western Gear pinion stands, gear drives and other machinery for application in steel rolling mills are backed by experience accumulated since 1888 in the design and construction of mechanical power transmission equipment of every description. It's your guarantee of ruggedness and trouble-free production day in and day out. Anti-friction bearings provide for rock-steady, vibration-free operation so essential to maintain high standards of accuracy and finish. And this same precision helps prolong the life of related machinery, too! Removable end plates on Western Gear pinion stands enable lifting entire gear train for easy inspection without removing housing from bed plate mounting.
To maintain top quality output with a minimum of downtime and overhead, insist on Western Gear drives for rolling mill application.

For recommendations on the installation of new equipment or the replacement of obsolete or worn units, write today. Our engineers will be glad to offer their help and experience. Address General Offices, Western Gear, P.O. Box 182, Lynwood, California.

"The difference is reliability" ★ Since 1888 5570

WESTERN GEAR *Corporation*
ENGINEERS AND MANUFACTURERS

PLANTS AT LYNWOOD, PASADENA, BELMONT, SAN FRANCISCO (CALIF.) SEATTLE AND HOUSTON—REPRESENTATIVES IN PRINCIPAL CITIES

Another Example of Better Bearing Engineering from **Bearings, Inc.**

NOW! PALLET WHEELS

for Sintering Plant Conveyors

Last and Last and Last!

Many steel plants are now depending on Bearings, Inc. to supply pallet wheel assemblies that give far greater service life than can be expected from other types of assemblies. And the reason? It's simple! Bearings, Inc. has designed a new and much improved labyrinth seal that retains the bearing lubricant and keeps out all dirt. The complete assembly is shown above. We supply seals for wheels in good condition or the complete assembly in single or double tread of flame hardened cast steel, complete with bearings.

BEARINGS, Inc., 3634 Euclid Ave., Cleveland 15, Ohio

Gentlemen:

I have a bearing problem I would like to discuss with you.

NAME_____

FIRM_____

ADDRESS_____

CITY_____ ZONE____ STATE_____

Bearings, Inc.

OHIO: [illegible] • Columbus • Dayton • Elyria • [illegible] • Lima • [illegible] • Youngstown • Zanesville

INDIANA: Ft. Wayne • [illegible] • Muncie • Terre Haute

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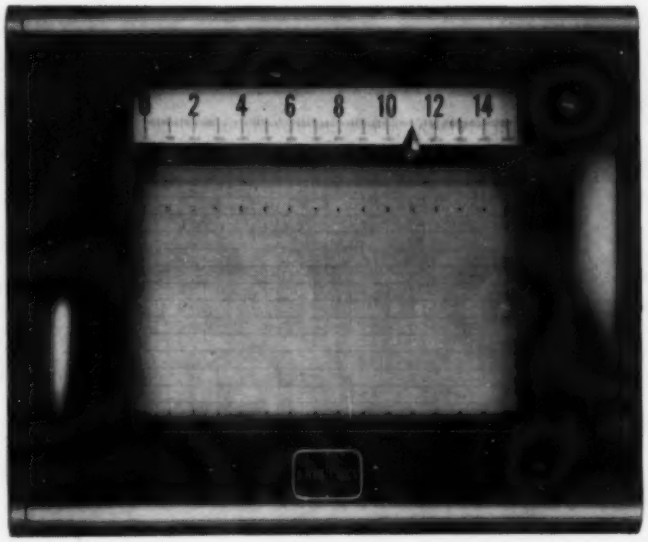
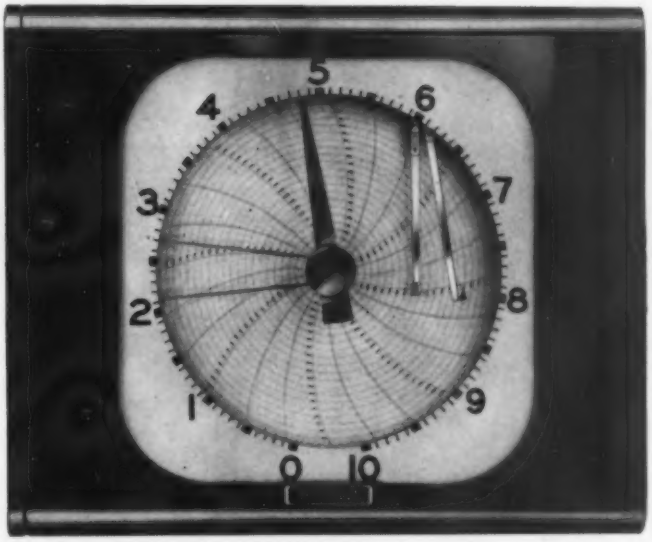
Subsidiary: Kentucky Ball and Roller Bearing Co. • Louisville, Ky.

WHAT'S NEW AT BRISTOL...

Three Ways to Better Temperature Control





BRISTOL ELECTRONIC DYNAMASTER® POTENTIOMETERS

CONTINUOUS STANDARDIZATION WITH NO DRY CELLS: Bristol Dynamaster Potentiometers with No-Batt Continuous Standardization which eliminates need for dry cells. Results: no interruption in operation for standardization, no batteries to replace.

A MODEL FOR EVERY REQUIREMENT: Dynamaster Potentiometers are available as single-pen, two-pen, and multiple-record (up to 24 points) *strip-chart* instruments and as *round-chart* instruments.

ELECTRIC AND PNEUMATIC CONTROLLERS. Both strip- and round-chart instruments are made in a very wide variety of controllers that meet every furnace and oven control requirement, including the following in a great many forms:

Electric Control — on-off, average position, proportional input, 3-position, proportioning, proportional with automatic reset, and time-program.

Pneumatic Control — on-off, proportional, and proportional with reset.

FREE-VANE® ELECTRONIC PYROMETER CONTROLLERS

- **Very minute changes in temperature** at the control point (less than 0.003" on scale) closes or opens the Thyratron-operated relay with positive trigger action.
- **New high-torque, rugged millivoltmeter measuring mechanism** gives greater accuracy — Alnico V magnet — and a sensitivity of 15 ohms per millivolt.
- **Separate control units are plug-in.**
- **Wide variety of models** — available in thermocouple and radiation pyrometer controllers in ranges up to 4000°F for L, H, LH, LOH, and LNH control and for L and H with proportional input control.

FOR MORE FACTS about these three rugged Bristol Furnace and Oven Controls write for free Bulletin P1260 today. It's a 48-page booklet of useful data, specifications, control diagrams and prices for every type of automatic heating control. The Bristol Company, 123 Bristol Road, Waterbury, Conn. 5.5

TRADE MARK BRISTOL'S REG. U.S. PAT. OFFICE

BRISTOL

POINTS THE WAY IN HUMAN-ENGINEERED INSTRUMENTATION

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

LINK-BELT announces MOTOGEARS and

MOTOGEARS

for bracket mounting NEMA foot-type motors of any manufacture . . . widest application flexibility . . . up to 60 hp

ABILITY TO ACCOMMODATE WIDE RANGE OF MOTORS solves emergencies, minimizes downtime.

EASY MOTOR REPLACEMENT is accomplished by removing four bolts and separating coupling—oil drainage is unnecessary. Motor bracket assures rapid realignment.

RIGIDITY of high speed shaft and pinion is provided by straddle-mounting—important in coping with shock, reversing and heavy loads.

STURDY BRACKET MOUNT is securely bolted to drive housing and provides rigid mounting for motor.

★ *Years-ahead design* — to harmonize with modern NEMA motors

★ *Stamina for the years ahead* — combining utmost compactness and highest efficiency for heavy-duty service

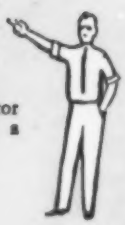
line of New, COMPACT GEARMOTORS...

GEARMOTORS

the ultimate in compactness . . . with flange-mounted NEMA motors . . . up to 30 hp

UTMOST COMPACTNESS is provided by flanged connection of motor to gear drive.

BUILT-IN ALIGNMENT of motor is provided through use of a rabbet-fit motor flange.



ONE-PIECE HOUSING cuts maintenance, offers added strength and assures oil-tight, quiet operation.

NEVER before has a speed reduction line offered this combination of features: *oil-tight design* having a minimum number of openings, each protected by an effective oil seal; *quiet operation* resulting from precision machining and noise-absorbing, cast iron housing; *standardization* with only one low-speed gear set per drive size; *compactness* derived from a unique gear arrangement; *integral backstop* with positive-locking action, which may be installed at any time. Learn all about these advanced new drives—ask your Link-Belt office or authorized stock-carrying distributor for Book 2447.

LINK-BELT

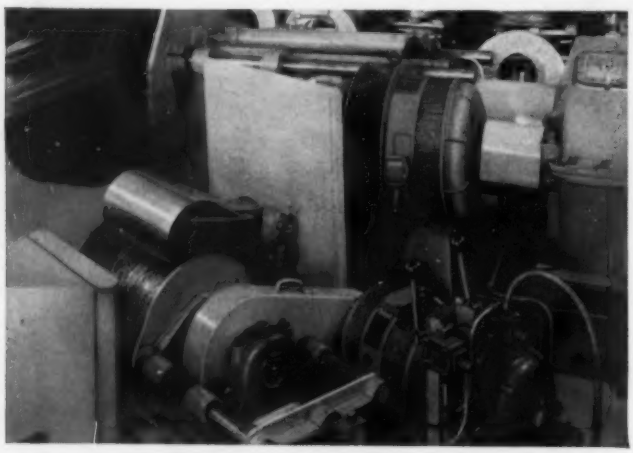
ENCLOSED DRIVES

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices, Stock Carrying Factory Branch Stores and Distributors in All Principal Cities. Export Office, New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World. 13.007

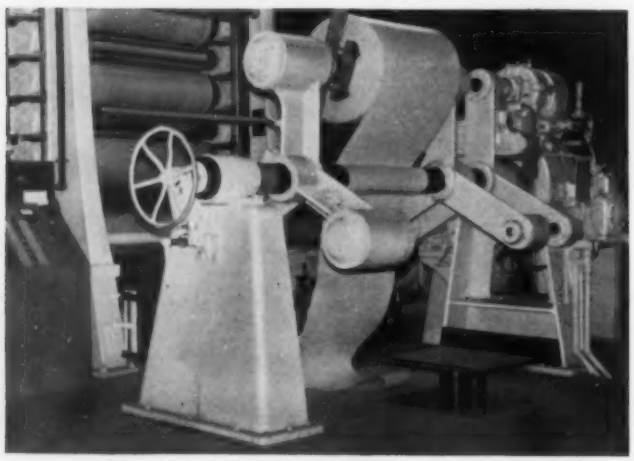
Tension Control Problems?

Dynamatic's Long Experience in Solving Industrial Windup and Unwind Problems will be Valuable to You

DYNAMATIC®



Metal slitter powered by Dynamatic Drives. Adjustable speed liquid cooled coupling used as main drive; Ajusto-Spede® Drives, with constant tension control, wind up the metal strips.



Completely Dynamatic driven paper super-calender. Adjustable speed liquid cooled couplings with Eddy-Current brakes drive the calender rolls and center rewinder. Dynamatic liquid cooled brake provides center unwind hold-back. Co-ordinated controls provide for wide-range adjustment of speed and tension.

Dynamatic Eddy-Current Drives with tension controls are used extensively in the fields of paper, rubber, textiles, ferrous and non-ferrous metals, plastics, and printing.

Combined with associated controls, Dynamatic Eddy-Current Drives provide automatic constant tension as the roll diameter changes on center rewinds and unwinds. Constant tension is maintained over a wide range of material delivery speeds without the use of dancer or follower rolls. Controls may be adjusted for tapered tension to increase or decrease tension automatically as the roll changes diameter.

Multi-range tension or tension adjustment over a wide range is easily accomplished at the operator's station to accommodate materials of various thicknesses or widths. Control modifications are available to provide for inertia compensation and other individual requirements. Dynamatic engineers are available for consultation on your problems.

Bulletins giving detailed information on Dynamatic Tension Control will be sent free at your request.

EATON

EATON

DYNAMATIC DIVISION
MANUFACTURING COMPANY
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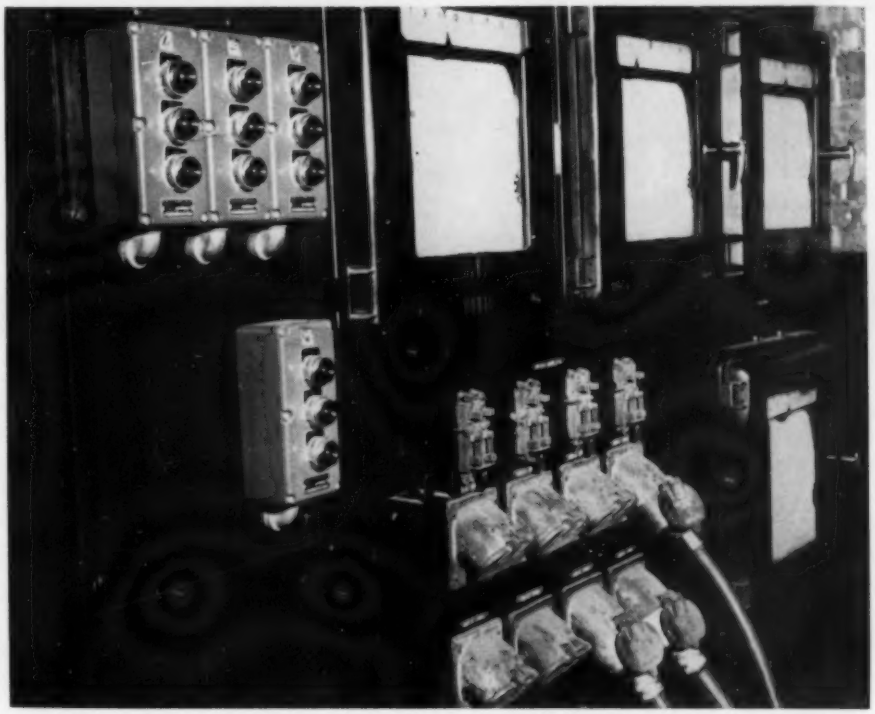
Sharon Steel Improves Annealing Temperature Control with New Thermocouple Circuit Monitoring Device



Pushing a Restorer button on the control panel disconnects the appropriate thermocouple circuit from its pyrometer circuits and puts a test voltage on the thermocouple circuit. A red signal light indicates circuit continuity. Pyrometer readings after button is released are accurate.

Restorer Checks Thermocouples Automatically...

● Another leading basic steel producer uses automatic Restorer units to verify quick immersion-thermocouple checks of molten steel to be tapped from its open hearths.

Automatic Restorers use the same electrical continuity principle as manual models, but they can be preset to operate automatically. They can also be operated manually, when necessary, by a push button or a key-operated switch.

Automatic Restorers are especially suited for monitoring immersion thermocouples in electric arc furnaces, induction furnaces or open hearths. These couples are often not welded and have many plug-type or screw-type connections that are common sources of poor electrical contact and excessive resistance.

The Restorer assures the accuracy of these critical temperature checks by insuring proper continuity between couple and pyrometer.

Seven coils of flat rolled strip steel are ready for annealing at Sharon Steel Corporation. Control couple near top cannot be reached for repair or replacement during heats.

Literature available upon request.

Restorer Prolongs Thermocouple Life, Cuts Maintenance of TC Circuits...

● Closer annealing temperature control, longer thermocouple life and reduced maintenance on thermocouple circuits and pyrometers has been effected at Sharon Steel Corporation's Roemer Works, Sharon, Pa.

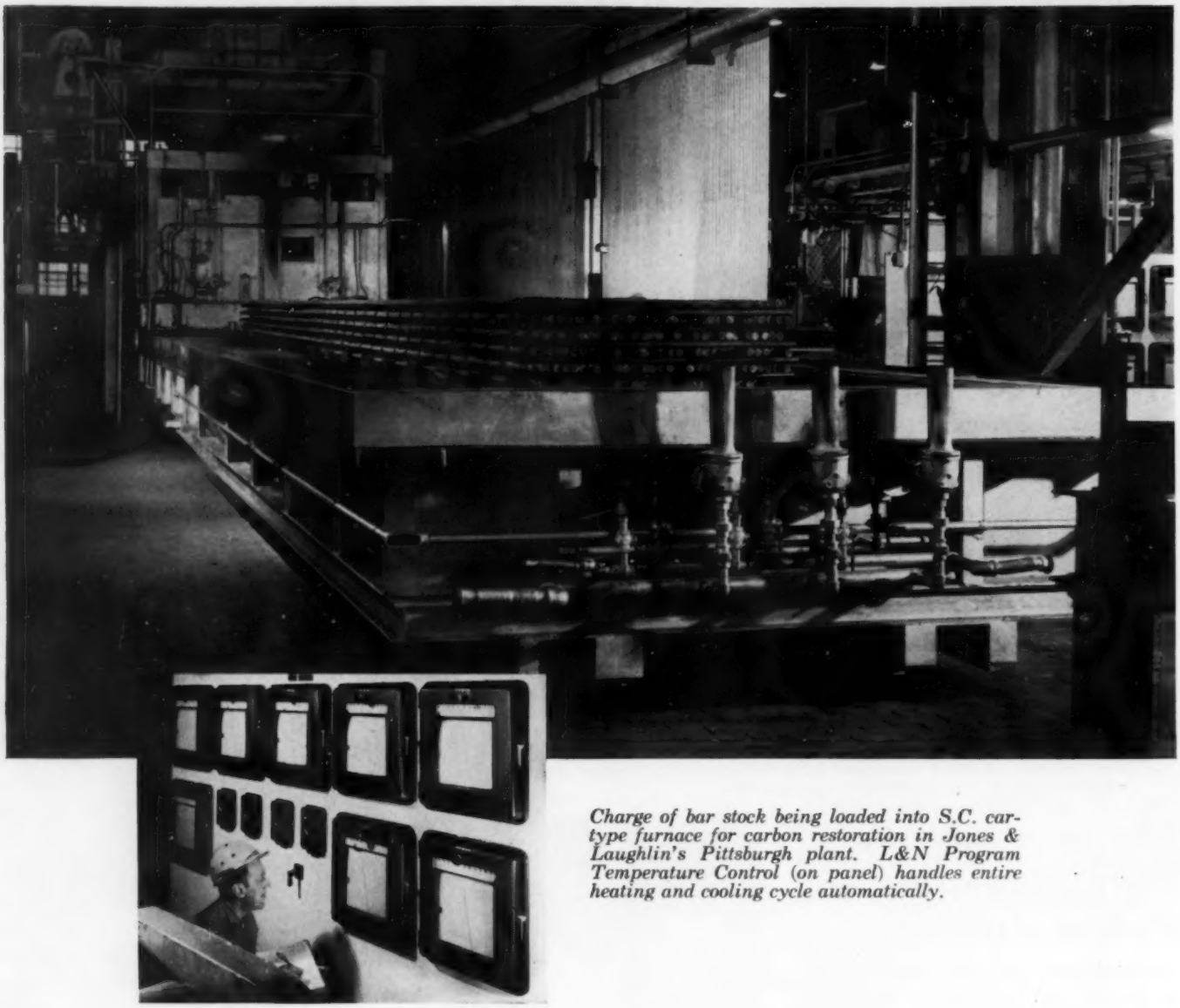
Annealing General Foreman, D. H. Jones reports his furnace operators and plant instrument men have made the improvement with the aid of a device for monitoring thermocouple circuits during heat treating operations. The unit is the Restorer, produced by The Peerless Electric Company, Warren, Ohio.

The first Restorer unit, installed on trial in June, 1953, permitted Annealing personnel to repair many couple failures "on the spot" without calling instrument men. Restored couples remained accurate during heats, instead of being replaced at the first sign of failure. Less time was spent checking pyrometers because couple failures account for the majority of troubles.

Sharon Steel installed five more Restorers in late 1953 to check more than 200 thermocouple circuits on its 23 annealing furnaces. This year the firm added new units and will again install Restorer monitor stations.

The furnaces anneal flat rolled steel strip produced by Sharon Steel.

THE
PEERLESS ELECTRIC
COMPANY
1451 W. MARKET ST.
WARREN, OHIO
Established - 1893
Manufacturers of
MOTORS · FANS · BLOWERS · ELECTRONIC EQUIPMENT



Charge of bar stock being loaded into S.C. car-type furnace for carbon restoration in Jones & Laughlin's Pittsburgh plant. L&N Program Temperature Control (on panel) handles entire heating and cooling cycle automatically.

Heat-treating Process Simplified at J&L

WITH LEEDS & NORTHRUP TEMPERATURE CONTROL

● Cold finished bar stock requiring a decarburization-free surface is being produced at Jones & Laughlin's Pittsburgh Works through restoration of surface carbon in a furnace closely regulated by reliable L&N temperature control. Previously this stock from the cold finishing department required expensive handling to remove the decarburized surface.

The temperature control is our P.A.T. system and the furnace is a Surface Combustion Corp. radiant tube installation, with S.C. gas generators. The L&N control incorporates proportional, reset and rate actions to counteract the effect of the various lags inherent in the heating operation.

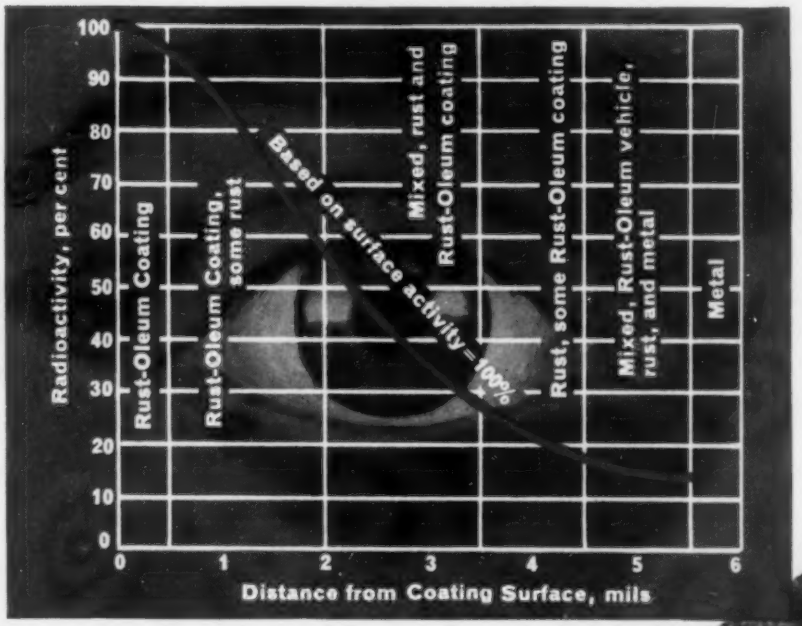
Control is provided in five zones: three in the furnace cover and two in each of the charge cars. Zones have two thermocouples apiece—one detecting the temperature of the work; the other the temperature of a radiant heating tube. The latter couple protects the radiant tubes by causing fuel to be cut back if maximum tube temperature is reached.

The P.A.T. program control uses motorized front setters, timers and interrupters to bring the heat up at specified rate and hold it for the proper time. Initial and final cooling rates are also held automatically.

P.A.T. program control simplifies the correct treating of a wide range of sizes and grades of steel under varying surface conditions. More information on control for this type of application or any other heat treating process is available from your nearest L&N representative or by writing Leeds & Northrup at 4942 Stenton Ave., Phila. 44, Pa.

LEEDS & NORTHRUP
instruments *automatic controls • furnaces*

See Rust-Oleum *penetrate* *rust* to bare metal through the "Eyes" of Radioactivity!



Curved line illustrates Rust-Oleum penetration through rust at each mil level as recorded by Geiger Counter.

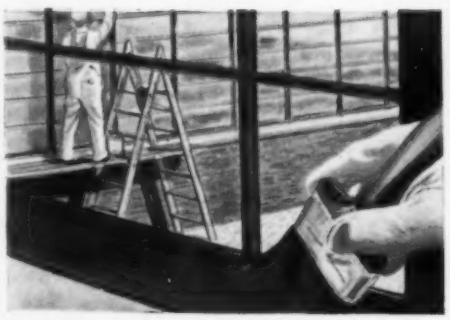
Rust-Oleum dries to a firm, decorative coating that resists salt water, sun, fumes, heat, humidity, and weathering.

Geiger Counter traces Rust-Oleum penetration to bare metal! In nearly three years of radioactive research, Rust-Oleum's *specially-processed* fish oil vehicle was radio-activated and formulated into Rust-Oleum 769 Damp-Proof Red Primer – then applied to rusted test panels. Rust-Oleum's specially-processed fish oil vehicle was then traced through the rust to bare metal by Geiger Counter.

This penetration means rust-stopping power, because the fish oil vehicle works its way into the tiny pits in the metal where it drives out air and moisture that cause rust. Important savings are yours, because Rust-Oleum can be applied directly over sound rusted surfaces – usually eliminating costly surface preparations. Attach coupon to your business letterhead for your copy of the thirty-page report entitled, "The Development of a Method To Determine The Degree of Penetration of a Rust-Oleum Fish-Oil-Based Coating Into Rust On Steel Specimens," prepared by Battelle Memorial Institute technologists. Prompt delivery of Rust-Oleum is assured from your nearby industrial distributor.

There is only one Rust-Oleum. It is distinctive as your own fingerprint.

RUST-OLEUM®



STOPS RUST!

Rust-Oleum is available in practically all colors, including aluminum and white. See our complete catalog in Sweets, or write for information.

ATTACH TO YOUR LETTERHEAD—MAIL TODAY!

Rust-Oleum Corporation
2441 Oakton Street
Evanston, Ill.

- ☐ Complete literature with color charts.
- ☐ Thirty-page report on Rust-Oleum penetration.
- ☐ Nearest source of supply.

Cleveland Cranes
FOR
STEEL MILL SERVICE
CLEVELAND CRANES
MODERN ALL-WELDED STEEL MILL CRANES
5031 EAST 289th ST.
WICKLIFFE, OHIO

Crops and Shorts

THE third western AISE meeting, held at Los Angeles, Calif., February 20, 21 and 22, was attended by 469 men from the iron and steel and allied industries — and a goodly number of their wives, as well.

Registration included 96 men from east of the Mississippi River, 250 from the Los Angeles area, and 123 from other western areas.

The program included excellent technical papers and a fine trip to the Los Angeles plant of Bethlehem Pacific Coast Steel Corp. Hotel Statler, with a physical layout for such affairs second to none, did its usual fine job.

And of course, Los Angeles provides lots of diversion for free time, with its many excellent restaurants of national repute. Perino's, Romanoff's, Mocambo, Lawry's — all attracted some of the visitors — to say nothing of our particular favorite, The Cove, presided over by mein hosts, Hans and Herman Wickhorst.

Next year's western meeting is scheduled for San Francisco, March 4, 5 and 6.

▲

THE Wall Street Journal says: "It's foolish to complain about how little your money buys these days. After all, you can't expect your dollars to do more for you than you did for them.

▲

STEEL companies are increasing educational activities to help relieve the shortage of engineers. Inland Steel Co. has announced the founding of 22 scholarships at 15 colleges and universities. Nine scholarships are for study in liberal arts and sciences, 13 in engineering. Each will allow the recipient $1500 per year and will give the school a grant-in-aid of $1000 per year.

The company will also offer vacation-time employment to any holders of scholarships who wish to supplement their income and obtain pre-graduation career experience.

▲

ALONG the same line, Armco Steel Corp. has established a new scholarship program to encourage engineering study. Each year, 16 scholarships ($650 per year for four years) will be awarded to high school seniors in communities where Armco plants are located. The scholarships cover courses in chemistry, physics or any of the standard engineering courses at any college or university.

WITH signs of spring beginning to show, the grass is definitely greener on the other side of the fence. This might be expected, since the neighborhood kids have been coasting down our terrace all winter.

▲

AND of course, spring also brings the seed catalogs, proving that hope springs eternal.

▲

SHIPMENTS of finished steel products in 1955, totaling a record 84,717,444 net tons, included 15,167,629 net tons of cold rolled sheets, 9,430,711 tons of hot rolled sheets, 2,864,497 tons of galvanized, 4,503,637 tons of electrolytic tin plate, 2,968,241 tons of standard pipe, 2,542,109 tons of oil country goods, 2,164,641 tons of concrete reinforcing bars and 4,736,987 tons of structural shapes, all records for those categories.

Principal customers of the industry were the automotive industry (18,721,880 tons), warehouses (15,758,005 tons), construction (13,663,939 tons), containers (6,723,074 tons), machinery and tools (4,699,024 tons), railroad (3,520,849 tons), electrical machinery and equipment (2,291,866 tons), and appliances, utensils and cutlery (2,199,114 tons).

▲

WITH the income tax season again with us, it's interesting to recall that a $10,000 income was taxed $70 in 1913, $950 in 1918, $90 in 1929, $1880 in 1955. We wonder if another valley will ever come — we've been on this peak for a long time.

▲

WE don't want to make this a page of verse but here are two that are too good to pass up.

From Powerfax, house organ of the Elliott Co.:

It's the little things that bother
And keep us on the rack.
We can sit upon a mountain
But not upon a tack.

And from the Wall Street Journal:

In market tactics I'm untaught,
Nor do I study as I ought
To keep abreast of current trends
Which might affect my dividends
I merely buy; I merely sell,
And doing so, I do as well
And very often lose as much
As those who keep in constant touch.

▲

THE Federal Government's suit against Mesta Machine Co. and Birdsboro Steel Foundry and Machine Co. on charges of price fixing and use of patent rights in restraint of trade ended in clearance of both companies. The charges applied particularly to the sale of cooling beds for rolling mills. It was ruled that the two firms were not competitors, did not fix prices and were not a dominant factor in the cooling bed field.

▲

EXPENDITURES for scientific research in the United States during 1955 is estimated at about $5,000,000,000, of which 75 per cent is handled by industry.

▲

THE Kaiser Steel plant at Fontana, Calif., is to be used as a location site for a motion picture, "Somewhere I'll Find Him."

WHEELABRATOR® DESCALES STRIP 50% to 100% FASTER ELIMINATES SCALE BREAKING, REDUCES ACID PROBLEMS

Preparing stainless for cold-rolling at Republic Steel Corporation

Better cleaning at lower cost has led Republic Steel Corp. to install the Wheelabrator mechanical descaling process to augment pickling in each of four strip lines in its Massillon, Ohio, plant. Chrome and chrome-nickel stainless coils are cleaned in preparation for cold rolling.

This process eliminates the cold mill scale breaking operation previously required on the straight chrome series of stainless steels. It also reduces the number of passes through the cleaning line required for surface defect removal. These benefits account for approximately 50% of the total savings achieved.

In addition, only two pickle tanks on each line are required instead of three used formerly. Fewer tanks mean less acid used. Less acid used means less acid for disposal, registering additional significant savings. At the same time production has been greatly increased because of the 50% to 100% faster cleaning speed of the Wheelabrator lines compared to straight pickling.

Descaling stainless steel strip is only one of the highly successful applications of Wheelabrator blast cleaning in steel finishing and processing — more than 70 Wheelabrator Cabinets are in use for such jobs as descaling carbon strip, sheet, slabs, billets, wire rod, structural steel shapes, etching mill rolls, etc.

For similar benefits in your own plant adopt this modern method of strip and sheet steel descaling. For more information, send today for Catalog 864.

WHEELABRATOR
CORPORATION
(Formerly American Wheelabrator & Equipment Corp.)

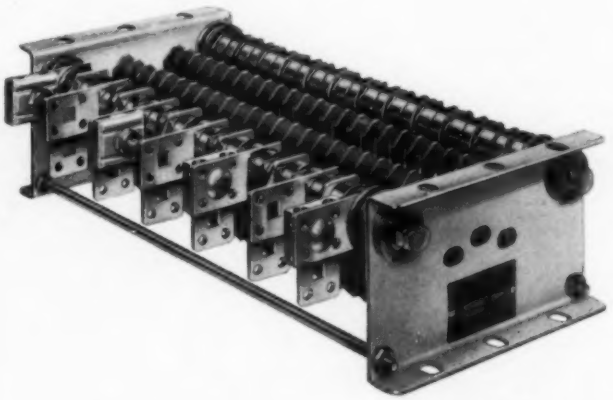
Leaders in the field of mechanical descaling

396 S. Byrkit Street, Mishawaka, Indiana

P-G *Steel Grid Resistors*

ARE BY COMPARISON SMALL UNITS... *but so important to production*

- **Steel Construction**
- **Mica Insulation**
- **Corrosion Resistant**
- **Vibration Proof**
- **Moisture Resistant**
- **Provision for Expansion**
- **Adequate Ventilation**
- **Rugged Terminals**



Resistors represent only a small part of a charging machine, but the duties they perform are of the utmost importance to its operation. In this stage of steel making, a charging machine must be able to start, stop, reverse and change speed regularly and continuously during its operating cycle. P-G Steel Grid Resistors have been handling their part of this job with a remarkable service record in many plants. For continuous "Trouble-Free Service" on this and all other steel mill applications, specify P-G the ORIGINAL Steel Grid Resistor.

Write for Bulletin 500.

P-G has BOTH! STANDARD Resistors — WELDED Resistors

P-G

The Nonbreakable Steel Grid Resistor

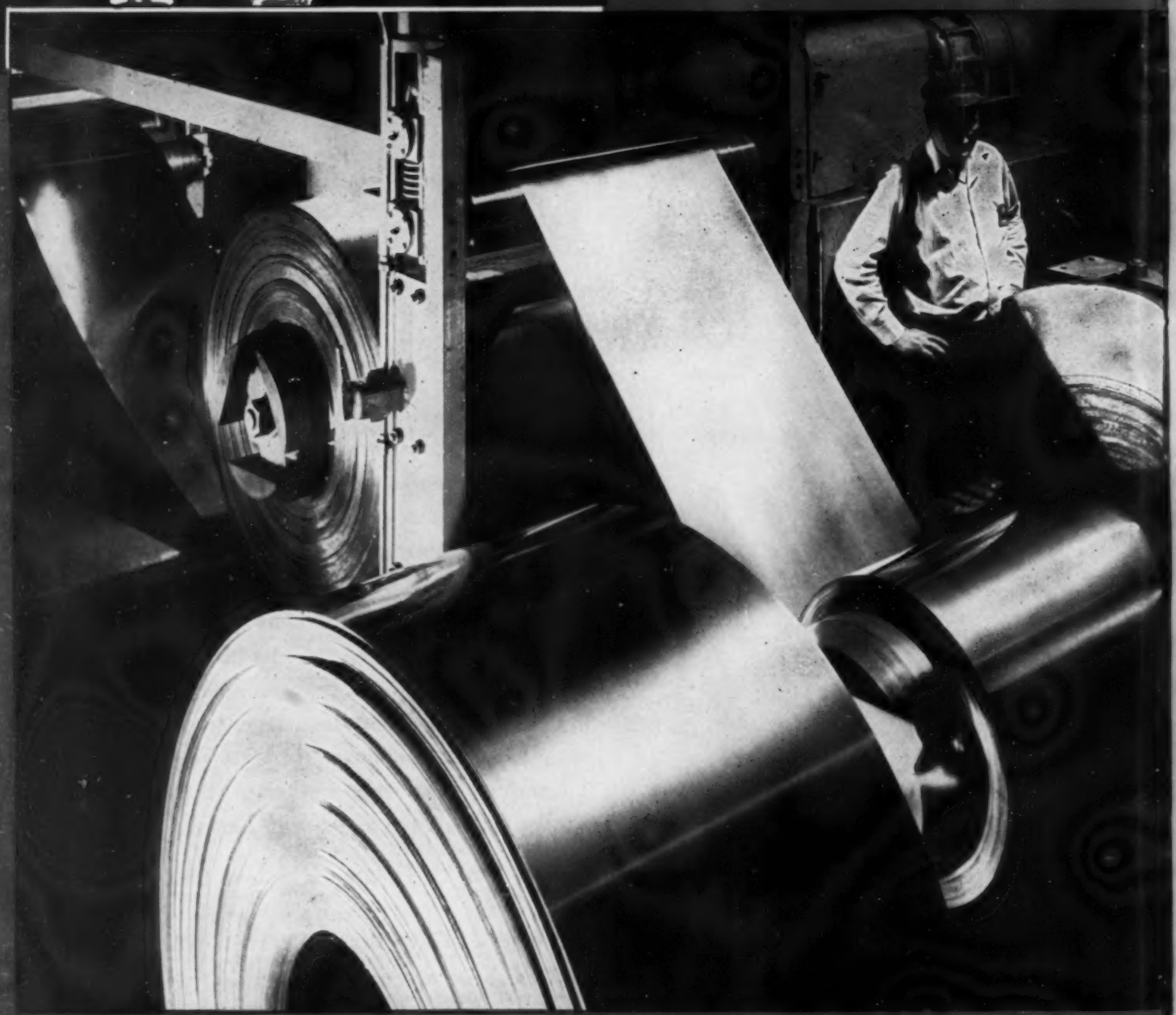
THE POST-GLOVER ELECTRIC COMPANY

• ESTABLISHED 1892 •

221 WEST THIRD STREET, CINCINNATI 2, OHIO

the WEAN ENGINEERING Company, Inc.

WARREN, OHIO



The Wean Engineering Company, Inc., Warren, Ohio is a recognized specialist in the design and installation of sheet, tin and strip mill equipment. The expert knowledge and trained imagination of one of the world's most noted steel mill engineering firms is at your service when you specify Wean—whether the job calls for a single piece of equipment or a complete design of an entire line.

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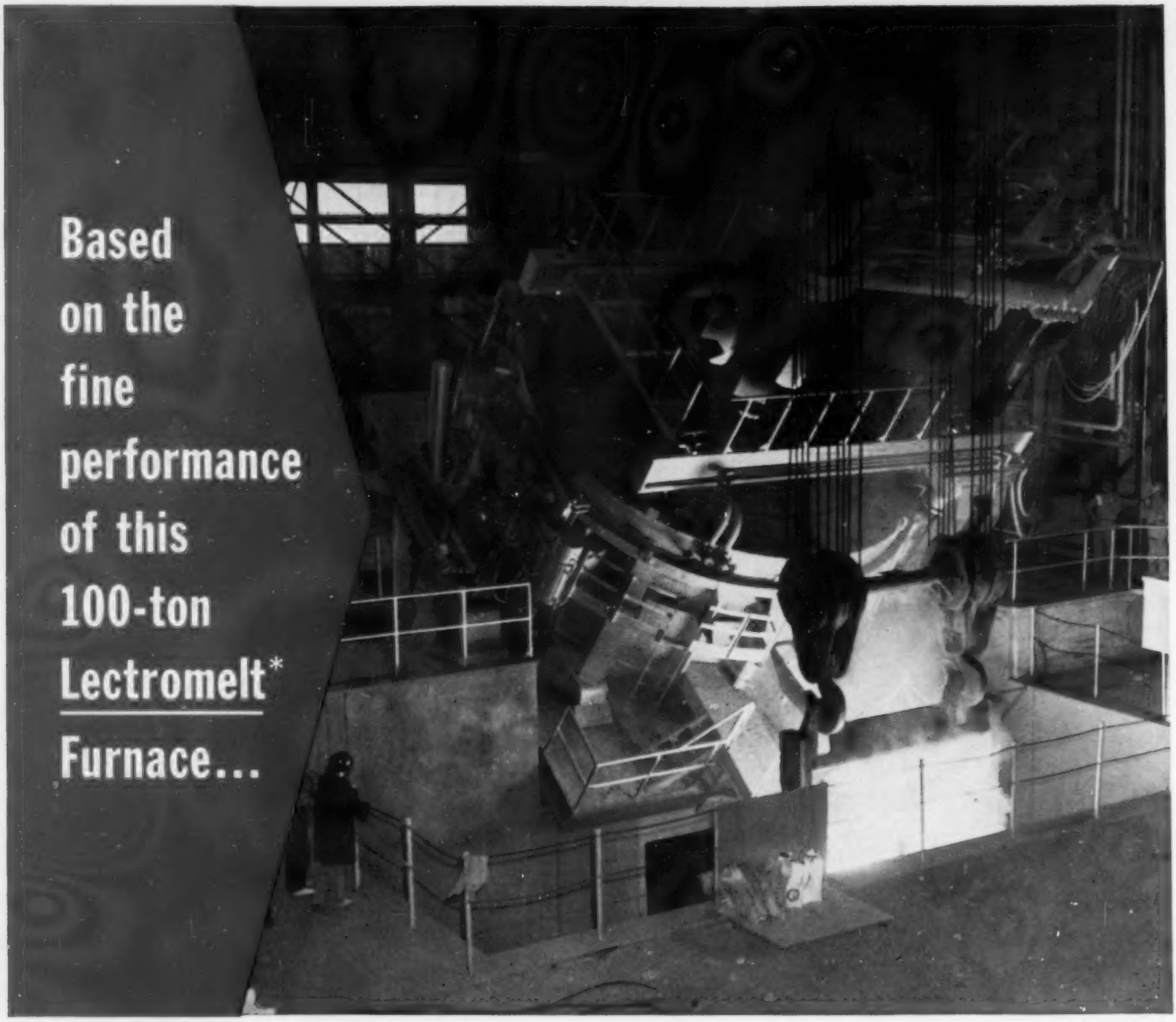

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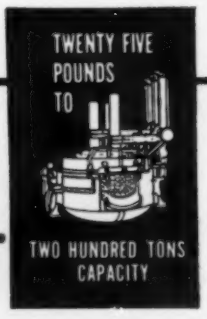

By
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and
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Pittsburgh, Pa.

Reducing Roll Breakage

. . . . a number of recommendations are given for getting better work roll life . . . . many are used and known by strip mill operators; however, the experimental and analytical work which has been done for the first time provides a logical basis for actual practice . . . . undoubtedly, improved practices can be developed from this research work which has been sponsored and financed by the Roll Manufacturers Institute and the Association of Iron and Steel Engineers, in cooperation with the Carnegie Institute of Technology and a number of steel companies . . . .

▲ THIS paper presents the final results of a study of fractured iron work rolls begun in 1952 at Carnegie Institute of Technology, under the joint sponsorship of the Association of Iron and Steel Engineers and the Roll Manufacturers Institute. The purpose of this study was to investigate the cause of breakage of alloy cast iron work rolls in four-high, continuous, hot strip steel mills. Four major types of fracture were studied.

1. Breaks in the main body of the roll, both perpendicular and angular (approximately 20 per cent of reported failures 1953). See Figure 1.
2. Breaks in the neck at end of roll (approximately 33 per cent of reported failures 1953.)
3. Spalls (approximately 43 per cent of reported failures 1953.)
4. Splits in the main body of the roll (approximately 4 per cent reported failures 1953).

Two previous reports, published in the Iron and Steel Engineer,[1-2]* discussed the various forces and resulting stresses existing in the rolls. This report, stripped of mathematical detail, summarizes the work and suggests ways that rollmaker and rolling mill operators can cooperate to prolong the life of work rolls. Each type of fracture will be discussed separately giving its cause and methods by which it may be eliminated or its frequency of occurrence substantially reduced.

Acknowledgments—The work presented in this and the following two papers was supervised by Dr. Charles F. Peck, Jr., under the administrative direction of Dr. F. T. Mavis. A. M. Belansky, A. M. DiGioia, Jr., R. E. Allison, and J. R. Verna, students in the Civil Engineering Department, carried out the necessary numerical calculations.

Special thanks are due E. I. Madsen of the Association of Iron and Steel Engineers, J. J. Marsalka, formerly of the Roll Manufacturers Institute, and N. R. Arant, of the Roll Manufacturers Institute, who, with the members of the joint committee of the Roll Manufacturers Institute and the Association of Iron and Steel Engineers, supported the study directly and through their liaison with the roll manufacturers and steel producers.

FRACTURE TYPE 1 — BREAKS IN THE MAIN BODY OF THE ROLL BOTH PERPENDICULAR AND ANGULAR

Figure 2 shows a roll which has a perpendicular break. This break may be caused by excessive temperature stresses, bending stresses, residual stresses, or a combination thereof. A previous report (2a) shows that the longitudinal stress in a roll due to temperature gradients alone can be as high as 24,000 psi in tension at a depth of 1¾ in. into the body of the roll for a roll heated "normally." A series of reported[4] tension tests of specimens cut from rolls showed the ultimate tensile strength and yield point to be higher than 24,000 psi for material at this depth from the surface. However, when a cold roll is heated too rapidly in rolling operations, a steeper temperature gradient with consequent higher stresses may occur.

The number of these thermal fractures can be decreased by carefully heating the rolls that are initially cold. Surface temperatures were measured on rolls during the warm up period in a mill.[3] These temperature measurements were made on 27 x 81-in. rolls which did not break during the test. If the surface temperature of a similar roll which is put into the mill cold does not exceed 170 F in the first six minutes of the warmup period and is not allowed to increase faster than 8 degrees F per min for the next eight minutes, the roll is not apt to break because of temperature stresses.

Operators realize that to start up a hot strip mill with cold rolls requires experience and some precaution in the heat control. Also during the warmup of a mill, other factors enter which tend to slow down the rolling

* Numbers refer to Bibliography at end of paper.

Type Break	No.	Per Cent
Big Spalls	269	33.8
Multiple Small Spalls	70	8.8
Vertical Body Breaks	130	16.3
Diagonal Body Breaks	15	1.9
Multiple Vertical Body Breaks	7	0.9
Corners Broken Off Main Body	4	0.5
Body Break Combined with Neck Break	7	0.9
Vertical Neck Break-Driving End	125	15.7
Neck Break-Close to Wabbler Driving End	28	3.5
Neck Break-Diagonal-Driving End	6	0.8
Neck Breaks-Both Necks	7	0.9
Vertical Neck Breaks-Thrust End	57	7.2
Wobbler Breaks-Driving End	42	5.2
Horizontal Splits, Multiple Horizontal Splits, Horizontal Splits Combined with Vertical Breaks	21	2.6
Break Location Unknown	8	1.0
	796	100.0

Figure 1 — Tabulation summarizes the various types and percentages of roll breaks which occurred in 1953 on 22 hot strip mills in the United States and Canada.

process, thus allowing the heat to soak into the rolls slowly. Slow heating of the roll by scheduling wide stock first, as is common practice, has a sound theoretical basis. This utilizes the full width of the roll before it becomes worn from the narrow metal. Rolling wide stock first reduces temperature gradients in the roll for two reasons:

1. The whole surface of the roll is heated uniformly which in itself will help reduce temperature stresses.
2. The time that heat is supplied is shorter with short, wide strip than with long narrow strip, and there is usually more time between passes.

A more critical time in the life of rolls is when only one pair of rolls is replaced in a mill which has been running, with rolling then resumed. If the operator immediately initiates the rapid rolling schedule previously maintained, disregarding that he has cold rolls in the mill, he may be inviting trouble. Surface temperatures in the new roll may rise rapidly enough to cause thermal stresses and fracture.

Perhaps the most critical or elusive failure will occur when the mill is shut down for periods of 15 minutes or longer. During this time the rolls may idle slowly or they may be stopped. The water may or may not be left on. In either case the rolls may cool substantially. At the same time the slabs remain in the furnaces longer and may become hotter than normal. When rolling resumes, the roller may wish to make up for the tonnage lost during shutdown and may start too fast, not realizing that the rolls have cooled substantially. Thus, too rapid heating of the surface of the roll which has cooled internally can cause breaks in the roll.

Figure 2 — Typical vertical perpendicular break in roll body is illustrated in this view.

It is suggested that a surface pyrometer be used to forestall failures from temperature stresses. The temperature measurements may not be accurate, but will still indicate relative variations for a roll in a given mill. Normal operating surface temperature of the rolls on each stand can be measured immediately after stopping the mill. Just before rolling after a shutdown, the surface temperature of each roll can be measured again. If it is appreciably below the normal operating temperature for that particular mill, care should be taken in warming the mill.

The optimum time and temperature-differential relationship which should be allowed in a particular stand in any mill can best be found from experience in that mill. However, the surface pyrometer could be used to advantage in mills to indicate when the shutdown has been long enough to be critical for the type of product being rolled.

Bending stress occurs when the backup roll and work roll do not match properly. Theoretically, the backup rolls carry all of the bending stress and the work rolls serve only to shape the steel. However, if the work rolls

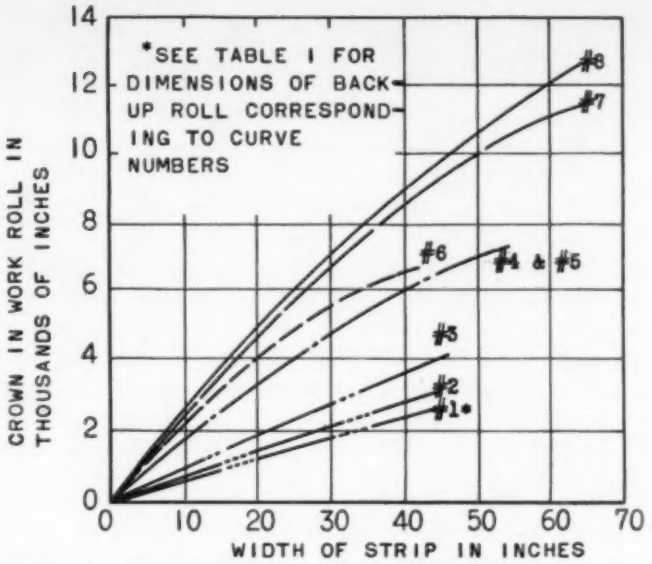


Figure 3 — Curves show practice of crowning on work rolls for eight different mills.

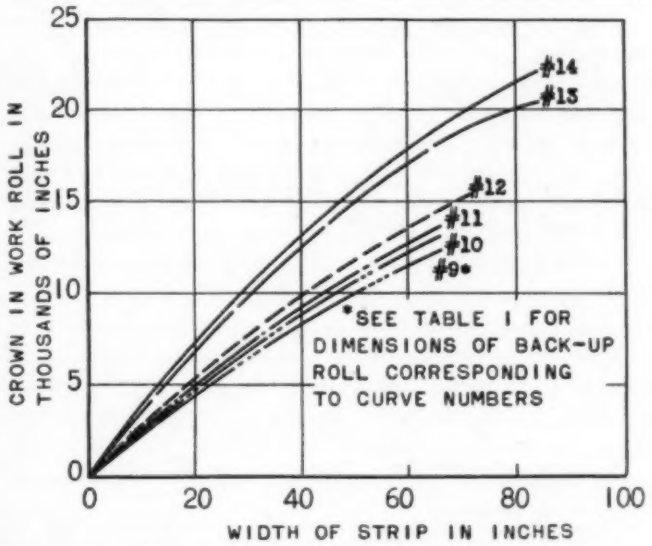


Figure 4 — Curves show practice of crowning on work rolls for six different mills.

Figure 5 — Curve shows crown of work roll for a relatively wide mill.

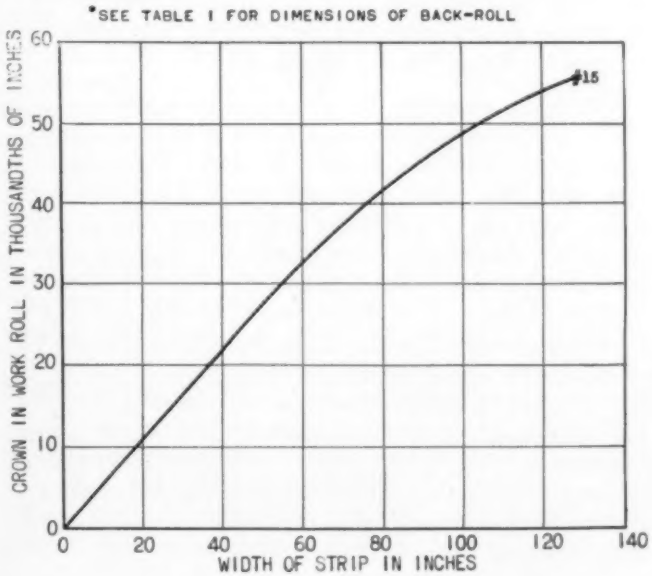
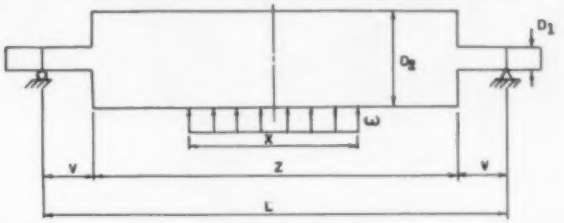


TABLE I

Backup Roll Dimensions



CURVE	VARYING X IN	Z IN	L IN	V IN	D_1 IN	D_2 IN
1	12 TO 48	48.000	88.750	20.375	31.650	51.000
2	12 TO 43	43.000	76.500	16.750	24.443	45.375
3	12 TO 45	45.000	77.000	16.000	28.000	44.000
4	12 TO 55	55.000	87.000	16.000	27.085	45.000
5	12 TO 55	55.000	87.000	16.000	21.155	45.000
6	12 TO 40	40.000	59.250	9.625	17.300	33.000
7	12 TO 66	66.000	101.000	17.500	25.460	46.375
8	12 TO 68	68.000	103.000	17.500	25.290	46.500
9	12 TO 80	80.000	123.000	21.500	31.905	54.000
10	12 TO 75	75.000	108.000	16.500	29.998	49.500
11	12 TO 75	75.000	108.000	16.500	29.998	49.000
12	12 TO 77	77.000	108.000	15.500	25.989	49.000
13	12 TO 90	90.000	126.000	18.000	32.998	53.000
14	12 TO 90	90.000	134.500	22.250	32.250	53.500
15	12 TO 130	130.000	172.000	21.000	33.000	59.000

and backup rolls are not properly shaped, the work roll will also bend. Figures 3, 4 and 5 show the proper net total crown on the work roll and backup roll to minimize bending while rolling various widths of strip.[2b] Table I gives the roll dimensions for the various curves shown in these figures. These crowns were computed for fifteen existing strip mills whose roll dimensions were furnished to the committee. This total crown may be in either the work roll or backup roll or divided in any proportion between the two.

Measurements of actual puffing of rolls during operation in mills and the amount of wear on the roll must be combined with the above calculations to determine the best contour to which the rolls should be ground while cold. If proper contours are not maintained, trouble may result in the mill. The material in the work roll has sufficient tensile strength to resist some bending; however, the material is brittle and cannot bend much before it fails, particularly if temperature and residual stresses are high, of the same sign (both tension or both compression). A small surface crack, such as a firecrack, can cause a concentration of stress so the roll may fail at a lower bending stress than the ultimate stress of the material as determined by a standard tensile test.

The contour of the roll plays an important part in the finished product. To maintain good tracking of the strip through the mill, good shape as the strip emerges from the mill, and minimum bending stresses, a compromise must be reached on roll contour.

Figure 6 — A diagonal break is shown in the main body of a roll.

Bending can occur in a horizontal plane as well as in a vertical plane. As the roll bites the strip it tends to "climb" the entering strip. This tends to pull the roll toward the entry side of the mill. If the roll is placed directly under the backup roll, it will tend to bend as it crawls out and forward. However, if the roll is properly placed toward the delivery side of the mill, it will be squeezed beneath the backup rolls and bending stresses will be negligible.

To minimize bending stresses and reduce fractures caused by bending in the roll, it is therefore important to maintain the proper camber on the rolls and alinement in the mill. Notches and grooves should not be permitted to form in the backup roll and work roll. The rolls should be kept in proper alinement at all times and the bearing boxes should fit tightly.

Doubled over ends which obviously magnify the bending stresses, can cause failures, and any roll subjected to more than one thickness of strip going through the roll gap can be suspected of breaking at a later date.

Figure 6 shows a diagonal break in the body of the roll. The break was probably started by one of many causes of splits or perpendicular breaks. The crack propagated diagonally because of torque on the roll. It can be noted that this crack coincides with the edge of the strip where temperature stresses are high.

A large number of rolls used in the hot strip mills are of the double-pour cast iron type. In casting these rolls, the mold is filled with high alloy iron and allowed to chill for a short time in the cast iron mold to form a hard outer shell. The unsolidified metal is then replaced or diluted with molten low alloy iron. This casting procedure leads to a complex stress problem. It is realized that other types of work rolls may also have residual stresses. Some of the residual stresses may be favorable (surface compression) and some may be unfavorable.

Surface strains on four rolls were measured with resistance wire strain gages. After the gage had been attached and read, the roll was cut apart and the relaxed surface strain was measured. From these surface strains, internal stresses were computed showing that the body of the roll is in tension. These tensile stresses have been known to become high enough to contribute materially toward roll fracture. It then becomes a question of just how high these stresses really might be in the roll. Certainly the residual stresses in all rolls are not the same.

Pilot work was done to develop a non-destructive test for determining these stresses. The Mathar method was used whereby a gage was fixed to the surface of a roll and a shallow hole bored into the roll at the end of the gage. This non-destructive test, supplementing analyses previously reported,[2-4] provides a basis for estimating the internal stresses. Perhaps the method we have explored here might be further developed as a quality control test of mutual value to both the roll manufacturer and mill operator.

Once a roll is placed in service, the residual stresses in it are continually changing. The roll is progressively being heat-treated in service, especially at the point of roll-slab contact. Some of the residual stresses are relieved in operation and as the roll is ground off for resurfacing, the residual compression stresses are further relieved. The residual tension stresses are correspondingly reduced.

FRACTURE TYPE 2 — BREAKS IN THE NECK FILLET AT END OF ROLL

The fracture, pictured in Figure 7, could have been caused by rough treatment or by excessive draft. When the rolls are put in the mill they are often hit to get them to slip into place. A hard off-center blow on the end of the roll could snap the neck. The fracture could also have occurred if the work roll and backup roll were not properly in contact with one another. If the work roll and backup roll are not maintained in intimate contact, the shock of the strip hitting the work roll may cause neck failure.

Any excessive mill loads caused by heavy draft or folded over ends might cause twisting or breaking in the neck. Wobbler breaks may be attributed to this. Redesign of the wobbler has proved helpful in eliminating breaks. More careful operation of the mill to reduce the draft on any one stand will also help to minimize neck breaks.

FRACTURE TYPE 3 — LARGE SPALLS

Large spalls are caused by excessive localized pressure or by sharp temperature gradients. The analyses [2c] show that the radial tension or spalling stress may be as high as 400 psi from normal rolling and 12,000 psi from normal temperature gradients.

Excessive pressure over a small area can cause a spall, particularly when cold spots, cold ends, or cold edges on strip move through the stand. Cold edges on strip and high temperature gradients in the roll occur at the same position and set up a dual reason for spalls. A spall need not occur immediately after excessive pressure on the roll, or cold ends and edges of the strip; the spall starts as a subsurface crack which is not immediately apparent. This crack propagates and eventually works to the surface, although subsequent stresses may not be excessive. This clouds the real cause of the spall, and operators and analysts may view causes of spalling differently. One would expect a higher incidence of spalling near the edges of the strip being rolled than at the center until convincing statistics are presented to the contrary.

Figure 7 — Breaks often occur in the neck fillet.

So far only the high pressure which can exist between the strip and the roll has been discussed. The method of support is assumed in the design to be a uniform load along the length of the roll. However, as soon as the work roll is thrown out of shape by the thermal expansion or surface wear, a condition of point contacts between work roll and backup roll is approached. Then a very high pressure is localized in the work roll and leads to spalling. If it were possible to maintain a better relative contour between work roll and backup roll these stresses might be reduced. Aside from eliminating cold edges and cobbles, a practical way to reduce spalling is through temperature control of the roll surface. There is a sharp temperature gradient at the edge of the strip. We have on occasion felt the roll after many similar strips had passed through the mill. The sharp temperature gradient becomes *real* when one part of the hand is burned and another feels cold. Any practical method of eliminating this temperature gradient should be seriously considered.

FRACTURE TYPE 4 — SPLITS IN THE BODY OF THE ROLL

Figure 8 shows a split roll. A split roll may be caused by residual stresses, high pressures, or sudden cooling of the surface. Residual stresses are discussed under Type 1 fracture. In a previous paper[2], it was shown that normal rolling pressures could cause tensile stresses of about 1500 psi if a small crack were present. This stress would become much higher at higher rolling pressure. A roll, which is overheated because the water is left off is very apt to split if care is not taken in cooling the roll. If the water is suddenly turned back on, the abrupt cooling of the surface will set up a high tangential stress with resulting failure.

SUMMARY

If the roll failures are to be further decreased cooperative effort must continue to exist between the maker and the user. The maker can contribute by studying more thoroughly the residual stresses in the rolls and the metallurgical methods whereby unfavorable stresses can be reduced.

The user can contribute to the reduction of failures by properly contouring and handling the work rolls. The large iron casting is not as rugged as many people think; it must be treated with some care. Just when a

Figure 8 — The horizontal split failure in this roll was probably caused by sudden surface cooling.

fracture actually starts is quite difficult to ascertain. If the exact cause of the failure is to be known, a more accurate record of the service history of the roll should be kept.

Proper cooling of the rolls is also important. The question of applying water to the roll has been controversial, but it is certain that water must reach the surface of the roll. When the surface of the roll is hotter than 212 F, the water immediately on the surface will form a steam blanket. This will keep additional water from striking the roll unless the pressure is great enough to force the water through the steam blanket. At points where the surface temperature is less than 212 F (and steam is not generated), it is important that a large volume of water reach the roll because not as much heat is removed by each pound of water. In general, high water *pressure* should be maintained on the *delivery* side of a stand, and a *large volume* of water should be applied on the *entry* side of a stand. We cannot over-emphasize the importance of keeping the sprays open and clean. If some sprays do not operate, the roll will become overheated locally, a hot band will form, and the surface will be damaged. Furthermore, one hot band around the roll could set up stresses high enough to cause fracture in the roll.

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   (a) Figure 8.

   (b) Figures 16 and 17.

   (c) Figures 6 and 13.

3. *"Roll Temperatures in a Hot Mill,"* by Albert M. Belansky and Charles F. Peck, Jr., Iron and Steel Engineer, March 1956.

4. *"Residual Stresses in Double-Pour, Cast Iron Work Rolls,"* by Anthony M. DiGioia, Jr., and Charles F. Peck, Jr., Iron and Steel Engineer, March 1956.

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Residual stresses in Double-Pour, Cast Iron Work Rolls

. . . . this report gives what is believed to be the first available data on residual stresses in work rolls . . . . data is also given on physical properties of material taken from actual rolls . . . . in test work, strains were measured and stresses computed, based on the best available knowledge of material properties at time of making test . . . .

▲ THIS paper presents an experimental method for determining residual stresses in double-pour, alloy cast iron work rolls. This work was carried out at Carnegie Institute of Technology under the joint sponsorship of the Association of Iron and Steel Engineers and the Roll Manufacturers Institute.

The residual stresses were studied by measuring the surface strains of the rolls experimentally. Four rolls were studied; one 18-in. roll which broke near its center while in service, and three new rolls of 12 in., 18, in. and 22-in. diameters tested as cast. Specimens cut from each roll were tested to determine the physical properties of the material.

EXPERIMENTAL DETERMINATION OF THE SURFACE STRAINS

Resistance wire strain gages were used to measure the residual strain in each roll. A general relaxation method was used whereby the strain gages were mounted to the roll while it was still intact. The section of the roll on which the strain gages were mounted was machined away from the rest of the roll and the relaxed strain measured with the aid of the wire resistance strain gages. Figure 1 shows the positioning of the gages on the rolls. The gages were placed alternately, lengthwise on the roll, and circumferentially around the roll. Rosettes were also used in the experimental work on the first roll; however, the shearing stresses measured with these rosettes were so widely scattered that these gages were omitted from the other three rolls.

The first roll tested was an 18-in. roll which had broken. The gages were mounted approximately at the midsection of one broken piece. See top of Figure 1. The other three rolls were prepared specially for this experiment. The body of each of these three rolls was made long enough so that a ring could be cut off for experimental purposes. See bottom of Figure 1. After this experiment was concluded, the body was machined so that a usable roll was obtained which could be used in a mill. On the broken roll where the gages were near the center of the body, two circumferencial plunge cuts were made at the edges of the portion of the roll containing the gages, and one undercut was made to free the ring-like piece. On the rolls having the gage ring near the end of the roll body, a similar piece was obtained. Only one plunge cut with the undercut was necessary to free the ring. The ring was then split. The different rings were from four to six in. wide measured along the rolls and from one to four in. thick along the radii.

Table I shows the final measured strain after all cuts were made on the roll. Plus values denote an elongation

Figure 1 — Gages were located tangentially and longitudinally on the roll. Top of this illustration shows the location of gages on the broken 18-in. rolls. The bottom of this figure shows the location of the gages on the other three rolls.

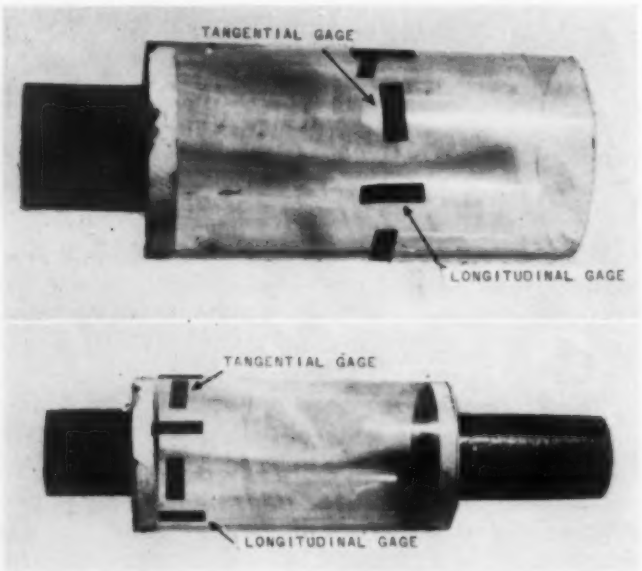

TABLE I

Final Residual Strains in Four Work Rolls

Gage location	Strain Micro-inches per inch							
	Broken 18-in. roll		22-in. roll		18-in. roll		12-in. roll	
	Long	Tang	Long	Tang	Long	Tang	Long	Tang
1	269	1302	330	885	870	1150	—35	190
2	555	946	825*	1020*	860	1080	55	190
3	387	845	335*	845*	965	1050	—45	210
4	1160	1962	5	1065*	893	1025	0	130
5	230	2302	725*	.... *	780	1020	....	....
6	....	....	340*	1085	775	....	....	....
7	....	....	585	1020	615	....	....	....
8	....	....	370	965	....	....	....	....
9	....	....	1235	1055	....	....	....	....
10	....	....	360	....	....	....	....	....
Total	2601	7357	5110	7940	5758	5325	—25	720
Avg.	520	1471	511	993	822	1065	—6.25	180

Ring Dimensions — In.

Outside diam.	18¾	22 5/16	19⅜	12 5/16
Inside diam.	17⅞	18 5/16	11⅜	10 11/16
Length	3¾	6⅛	6½	5¼

*Gages used in Mathar Method — See Table II.

upon relief, or a residual compressive strain. The strain measurements varied around the rolls, particularly those taken in the longitudinal direction. This variation may be caused by one or several factors such as temperature structure, segregation, etc. It is not felt that the variation is due to experimental error. The gages were not placed close enough together to detect a pattern. The readings shown in Table I are the average of three or more measurements at each point.

Machining the rolls was time consuming, tedious and expensive. To determine a simpler practical method which could be used as a control in the roll shop, the Mathar method was tried on one roll. This method consists of drilling a hole at the end of one resistance wire strain gage and measuring the strain relaxed by this hole.

The roll chosen for this experiment was the 22-in. roll. Two sets of four gages were placed on the roll as shown in Figure 2. While the roll was solid, carbide tip masonry drills were used to drill holes about a quarter of an in. deep at the ends of the gages. A ¼-in. drill was used on one set of gages, and a ⅜-in. drill on the other. Table II shows the results of this experiment. The table shows that in this particular case, drilling the ¼-in. hole relaxed approximately 23 per cent of the total strain as determined by freeing and splitting the ring, and drilling the ⅜-in. hole relaxed about 10 per cent. Although the experimental results have a great deal of scatter, they serve to show that the method might be developed to determine the order of magnitude of the residual strain on the rolls. Tests of the method on other structures have shown that with the properly selected strain gages, holes, and relationship of hole diameter to the distance from the end of the strain gages, up to 100 per cent of the internal strains can be relieved. This method might therefore be used on the rough cast roll by polishing or grinding one or more areas, applying the strain gages, drilling the hole, and measuring the relaxed strain. If the hole were drilled no deeper than the thickness allowed for finishing the roll, no damage would be done to the roll itself.

TENSION TESTS AND THE DETERMINATION OF RESIDUAL SURFACE STRESSES

The expression for converting the measured strains to stresses is:

Figure 2 — In Mathar method, a hole is drilled at the intersection of the lines formed by four gages. The gages are put on first, and the holes are drilled afterwards.

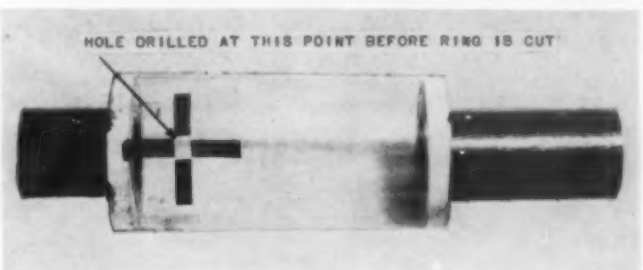

TABLE II

Residual Strains by Mathar Method in 22-In. Roll

Gage no. from table I	Hole size, in.	Strain relieved by drilling at one end of gage, micro-in. per in.		Total strain relieved by machining, micro-in. per in.	
		Long.	Tang	Long	Tang
2		.....	120	.....	1020
2	3/8	110	.....	825	.....
3		.....	150	.....	845
3		—10	.....	335	.....
4		.....	140	.....	1065
5	1/4	80	.....	725	.....
5		.....	100	.....	*
6		115	.....	340	.....

*Gage damage, no reading.

$$S_1 = \frac{E}{1-\mu^2}\left(\epsilon_1 + \mu\epsilon_2\right)$$

where S_1 = stress

ϵ_1 = strain in direction of S_1

ϵ_2 = strain at right angles to S_1

E = modulus of elasticity

μ = Poisson's ratio

Before the strains can be converted to stresses the modulus of elasticity and Poisson's ratio must be known. The value of the modulus of elasticity was determined from tensile tests conducted in the civil engineering laboratory of Carnegie Institute of Technology. The value of Poisson's ratio was obtained from data compiled by the Roll Manufacturers Institute.

Figure 3 shows the dimensions of three of the tension test specimens which were used. The specimen from the first 18-in. roll was cut as shown in Figure 3 in the shop of the civil engineering laboratory at the Carnegie Institute of Technology and was the only specimen from this roll. The specimens from the other rolls, cut by members of the Roll Manufacturers Institute, and the Jones & Laughlin Steel Corp., are also shown in

Figure 3 — Special tensile test specimens used are shown in these three sketches.

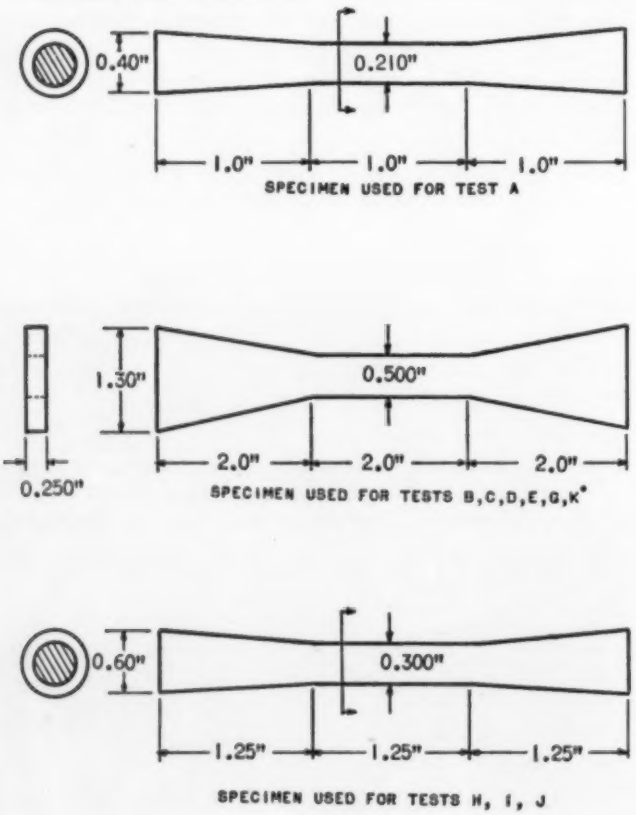

Figure 4 — Curves give stress strain data for the tensile tests.

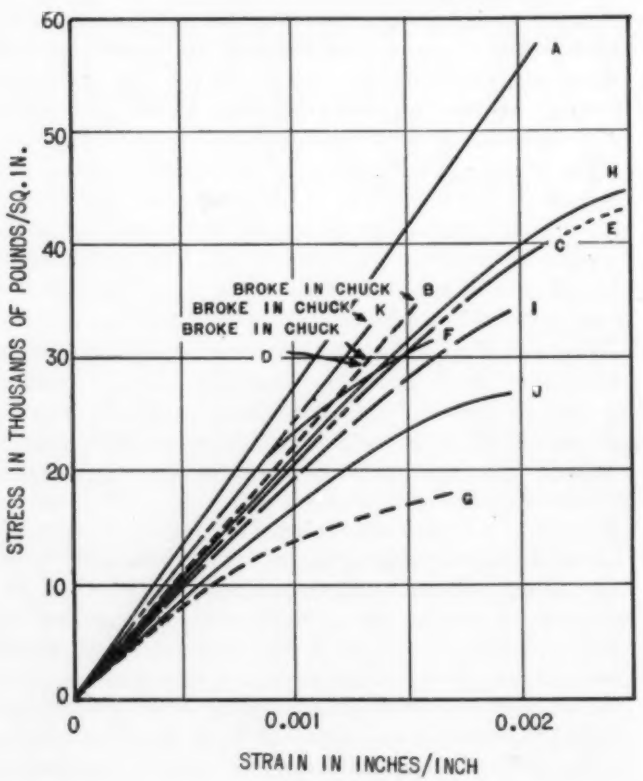

TABLE III

Data On Tensile Test Specimens

Test specimen	Roll	Location (Depth from surface, in.)	Hardness Rockwell C	Modulus of elasticity, psi	Ultimate tensile strength, psi
A	Broken 18-in.	1/4	—	28,000,000	58,000
B	12-in.	5/16	—	22,900,000	36,000*
C	12-in.	7/8	—	20,000,000	40,000
D	18-in.	5/16	59	22,500,000	30,000*
E	18-in.	1	58	21,200,000	46,000
F	18-in.	3	28	22,800,000	33,000
G	18-in.	3 7/8	27	15,900,000	20,000
H	18-in.	19/32	60	21,800,000	49,000
I	18-in.	1 1/4	53	20,100,000	34,000
J	18-in.	1 25/32	25	16,000,000	29,000
K	22-in.	1 1/16	32	24,300,000	33,000*

*Broke in chuck.

TABLE IV

Surface Stresses, Compression

Roll	Longitudinal stresses, psi	Tangential stresses, psi
18-In. broken	$Sl=\frac{28}{1-(0.28)^2}[520+0.28(1471)]=28,330$	$St=\frac{28}{1-(0.28)^2}[1471+0.28(520)]=49,157$
22-In.	$Sl=\frac{23.75}{1-(0.28)^2}[511+0.28(993)]=20,360$	$St=\frac{23.75}{1-(0.28)^2}[993+0.28(511)]=29,310$
18-In.	$Sl=\frac{23.75}{1-(0.28)^2}[822+0.28(1065)]=29,000$	$St=\frac{23.75}{1-(0.28)^2}[1065+0.28(822)]=33,500$
12-In.	$Sl=\frac{23.75}{1-(0.28)^2}[-6.25+0.28(180)]=1,120$	$St=\frac{23.75}{1-(0.28)^2}[180+0.28(-6.25)]=4,590$

Figure 3 with the exception of one, specimen F, which was a standard ASTM 0.505-in. tensile test. Resistance wire strain gages were placed on each specimen before they were mounted in chucks made for this purpose. Two strain gages were placed on each specimen. As the load was applied in the testing machine, the specimen was moved in the chucks until linear strain across the face of the specimen was achieved.

Figure 4 shows the results of the tension tests. Table III gives test data and also the locations from which the tensile specimens were taken. This data was used in the conversion of the measured strains shown in Table I into the stresses shown in Table IV. It should be noted here that the stresses in the unbroken 18-in. roll may not be the final residual stresses. When the last strain relief measurements were made on this roll, the machining was not complete (the ring was still about four in. thick) and it may be that this roll is not completely relaxed.

SUMMARY

The results of these tests show that there are high surface compressive stresses in the rolls. These surface stresses are balanced by corresponding internal tensile stresses whose magnitude will vary with the surface stresses. The data is insufficient to draw any rigorous conclusions as to the exact magnitude of the surface stresses or how they may vary with casting size. The relationship between these surface stresses and service life warrants further study. Development or modification of the Mathar method offers possibilities for experimental determination of surface strains.

The surface stresses which were measured were all compressive and in themselves would not cause failure. Failures might be caused by the tension stresses which exist internally to balance the surface stresses. Residual surface compressive stresses may be beneficial if they occur at locations which are stressed in tension during operation.

Figure 5 — Iron work rolls for 4-high continuous sheet and plate mills are shown in a modern roll shop.

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Roll Temperature Study on a Hot Strip Mill

. . . . the development of a brush thermocouple provides a means of getting actual temperature data on strip mill rolls as the product passes through the mill . . . .

▲ THIS paper presents results of a work roll surface temperature study utilizing a method of temperature measurement which could be used in any mill. This study, a part of a program for determining causes of roll breakage, was begun in the summer of 1954 at Bethlehem Steel Co., Sparrows Point, Md. The thermocouples used were developed and patented and are the property of the research department of the Bethlehem Steel Co. They can be used to measure the temperature of moving steel during processing. The results of the preliminary study were reported in the Iron and Steel Engineer[1].* Although these early results were not too consistent, they served as a guide for the work presented in this paper.

DESCRIPTION OF THERMOCOUPLE

The thermocouples used consist of two brushes, one made with iron bristles and the other with constantan bristles. The two brushes are held on the iron roll about ¾ in. apart. The point of temperature measurement is the contact area between the iron roll and the constantan brush. The iron brush serves only to complete the iron circuit to the cold junction in the potentiometer.

* Numbers refer to Bibliography at end of paper.

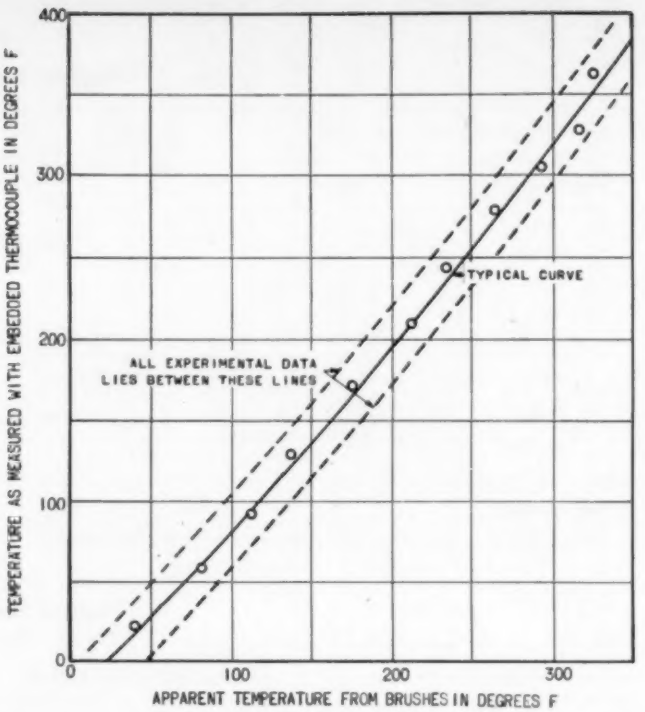
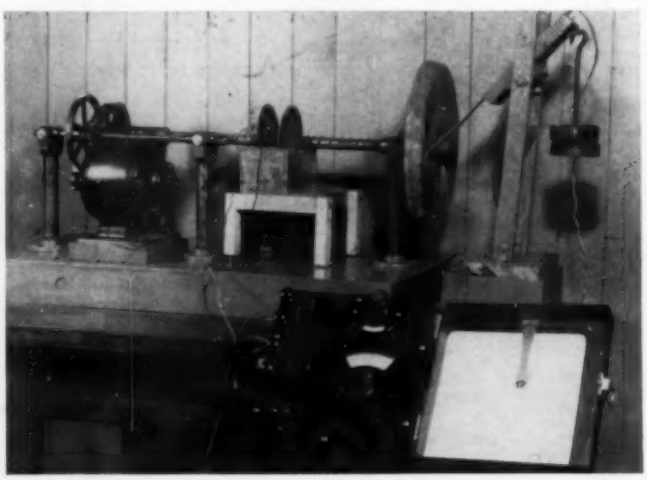


Figure 1 — Calibration curve for brush thermocouple shows good accuracy.

THERMOCOUPLE CALIBRATION

Figure 1 shows the calibration curve for the brush thermocouples. The thermocouples were calibrated by holding them against the side of a revolving cast iron alloy flywheel. The temperature of the flywheel was measured with a conventional thermocouple embedded in the surface of the wheel. The wheel was heated with blow torches applied to the face opposite to where the brushes were in contact. Figure 2 shows the calibration apparatus.

Figure 2 — This calibration apparatus was used to check the accuracy of the brush thermocouple.



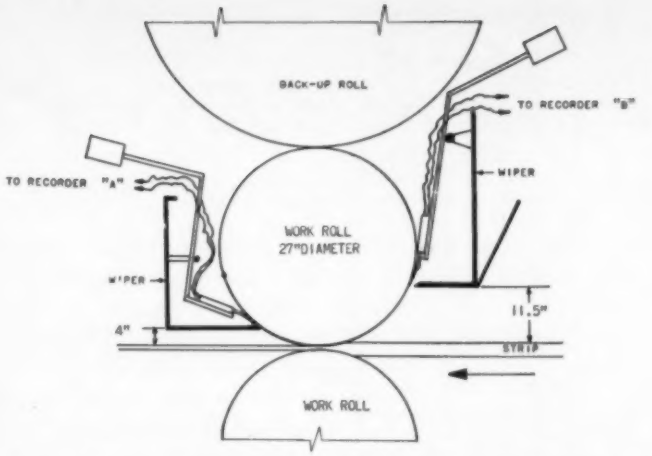


Figure 3 — Sketch shows locations of brush thermocouples on strip mill work roll. Unfortunately it was not possible to place instruments closer to the roll bite.

Two sets of brushes were calibrated varying the following:

1. Surface speed.
2. Contact pressure.
3. Contact angle.
4. Surface condition.
5. Wet and dry surface.

It was necessary to consider the effects of each of these factors experimentally since they cannot be controlled readily in the mill.

The surface speed was varied by moving the brushes nearer to or farther from the center of the flywheel which operated at constant speed. The embedded conventional thermocouple was moved to the contact point of the brushes at each position. The contact pressure was varied by hanging different weights on the counter-balance system. The contact angle was varied by moving the fulcrum of the counter-balance system nearer to or farther from the surface. The surface condition was varied by using a rough cast wheel then a smoothly ground wheel. When the variables were considered separately, each curve showing the relationship between the apparent brush temperature and the embedded thermocouple temperature, the calibration curves possessed identical slopes at any point along the calibration band. Each curve fell within the outer limits of the calibration. All other brush thermocouples were spot-checked before use in the mill. When Figure 1 is used to determine the surface temperature, it should be remembered that all temperatures are correct only to ± 20 F, the experimental tolerance.

INSTRUMENTATION

Figure 3 shows the positions of the brush thermocouples which were placed close to the center of the 27-in. work rolls in stands No. 6 and No. 9. Point A in Figure 3 is as close as possible to the point of delivery and point B is as close as possible to the point of entry of the strip. The contact positions available were limited due to the space taken by the functional apparatus such as wipers, spray nozzles, slab guides, and backup roll. Care was also taken that the thermocouples did not interfere with the strip as it passed, thereby minimizing possible interference to normal rolling. To place the delivery side thermocouple near the roll-strip contact, the bristles of the thermocouple had to oppose the direction of the roll motion. Additional thermocouple calibration showed that the calibration curve was unchanged.

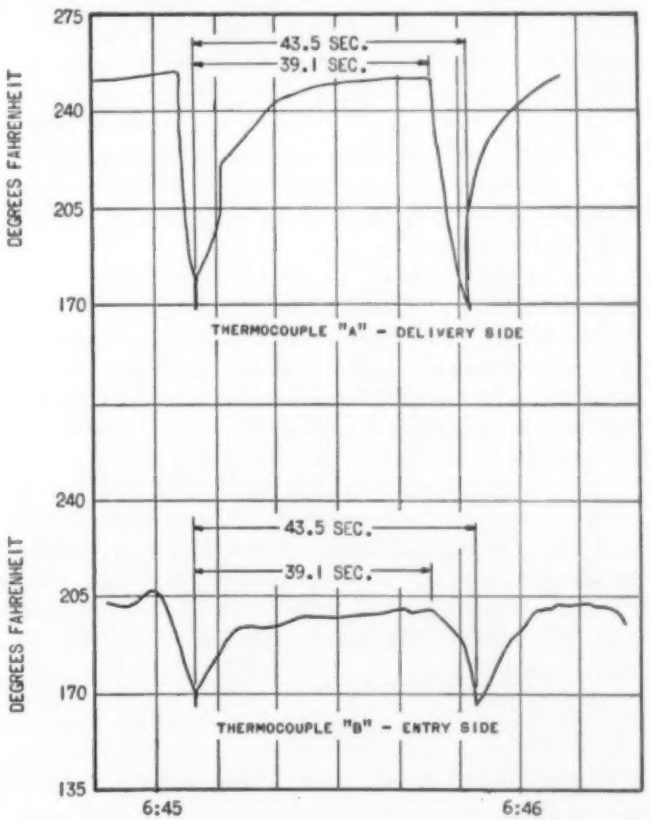
Each of the iron-constantan brush thermocouples was connected to a continuous-recorder, so that all temperature effects of hot strip passing between the work rolls could be determined at the points of contact for any time.

ANALYSIS OF MILL DATA

Figure 4 shows a typical temperature-time plot during the passage of a strip length from one slab through stand No. 9. Shortly after the strip contacts the roll, the temperature of the roll increases sharply and then continues to increase gradually for the remainder of the time the strip is in the stand. The maximum temperature on the roll is attained at the instant the back end of the strip is passing between the rolls. Immediately after this, the temperature of the roll drops rapidly until another strip enters.

Figure 5 shows the temperature on the top work roll of stand No. 6 for periods of continuous rolling. The strip temperatures and average strip frequencies are shown. The strip frequencies represent the percentage of time the strip was in the stand. A ten-minute time increment was used to compute these averages. Figure 6 shows a similar plot for the top work roll of stand No. 9.

Figure 4 — Passage of strip through mill stand causes relatively large variations in surface temperature of roll.



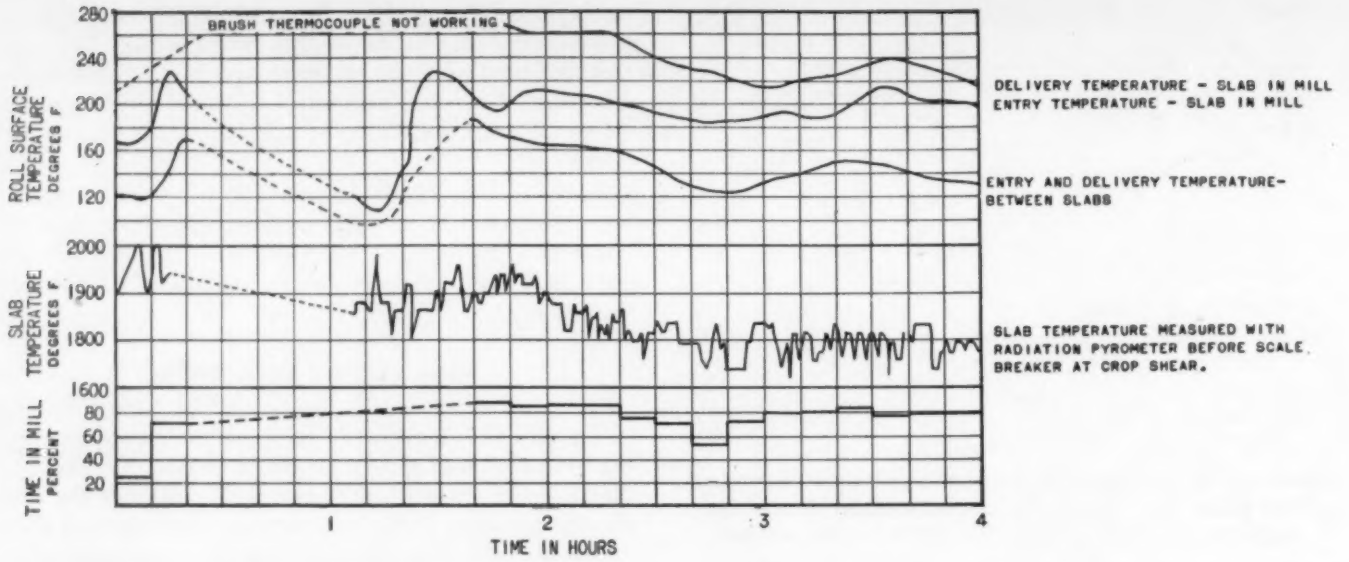

BRUSH THERMOCOUPLE NOT WORKING
ROLL SURFACE TEMPERATURE DEGREES F
SLAB TEMPERATURE DEGREES F
TIME IN MILL PERCENT
TIME IN HOURS
DELIVERY TEMPERATURE - SLAB IN MILL
ENTRY TEMPERATURE - SLAB IN MILL
ENTRY AND DELIVERY TEMPERATURE-BETWEEN SLABS
SLAB TEMPERATURE MEASURED WITH RADIATION PYROMETER BEFORE SCALE BREAKER AT CROP SHEAR.

Figure 5 — Chart shows temperatures of slab and No. 6 stand roll with a series of slabs passing through the mill.

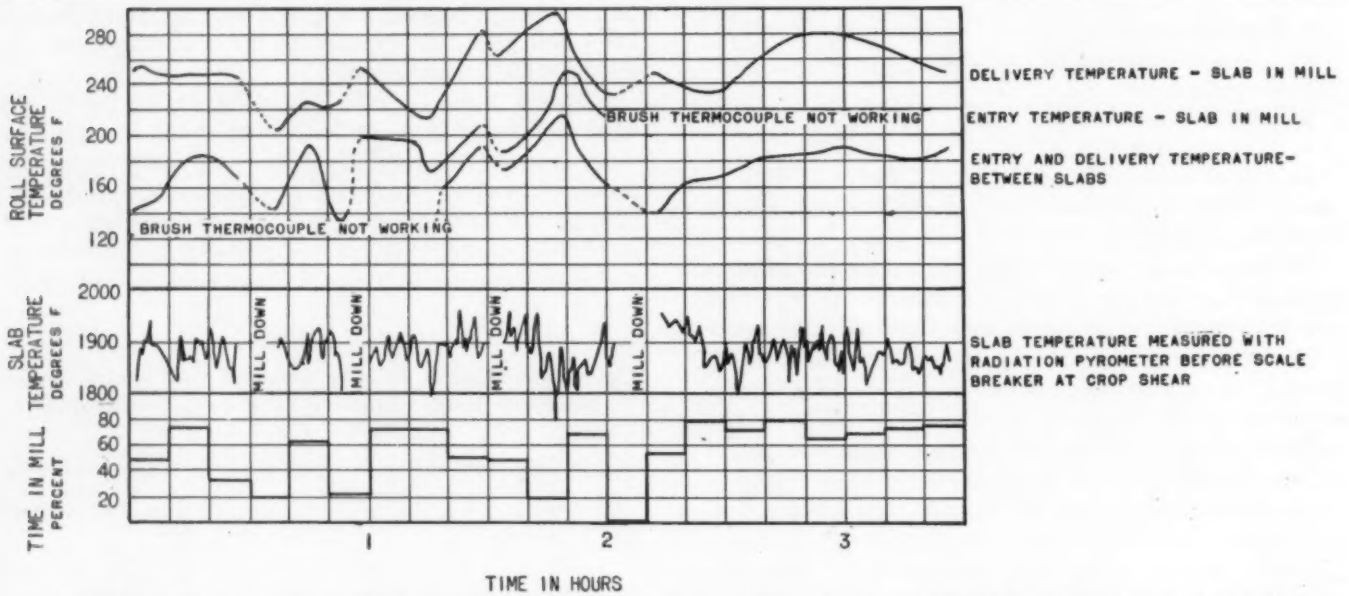

ROLL SURFACE TEMPERATURE DEGREES F
SLAB TEMPERATURE DEGREES F
TIME IN MILL PERCENT
BRUSH THERMOCOUPLE NOT WORKING
BRUSH THERMOCOUPLE NOT WORKING
MILL DOWN
MILL DOWN
MILL DOWN
MILL DOWN
TIME IN HOURS
DELIVERY TEMPERATURE - SLAB IN MILL
ENTRY TEMPERATURE - SLAB IN MILL
ENTRY AND DELIVERY TEMPERATURE-BETWEEN SLABS
SLAB TEMPERATURE MEASURED WITH RADIATION PYROMETER BEFORE SCALE BREAKER AT CROP SHEAR

Figure 6 — Chart shows temperature of slab and No. 9 stand roll with a series of slabs passing through the mill.

Figures 5 and 6 show that the temperature in a roll is dependent upon:

1. Strip temperature.
2. Frequency of pass.

(The coolant temperature must also contribute, but in these studies the temperature of the coolant remained constant at about 120 F after the first few slabs had passed. The length of bite is also an important factor but was not a variable in this test.)

The temperature measurements upon which the curves are based were made on different days. Therefore, no comparison between the measured surface temperatures of the rolls on stands No. 6 and No. 9 should be made since the strip temperatures and speed of rolling differed. The product being rolled may also have been different.

SUMMARY

This study illustrates work which could be done in mills to learn more about temperature stresses in the rolls. The curves shown in Figure 4 are typical of many which are obtained during the passage of strip through the mill. A closer study of these and similar curves from other rolls could clarify the temperature problems in the rolls. These measured surface temperatures are close to the assumed values used to determine the internal temperature distributions in work rolls.[2] The resulting stresses in these rolls will therefore be similar to those determined on the basis of the assumed surface temperature. Closer values of the actual stresses can be determined by "feeding" the actual measured surface temperatures into the general solution for internal temperatures and stresses.

BIBLIOGRAPHY

1. *"A Study of Failures in Iron Work Rolls,"* by Charles F. Peck, Jr., and Frederic T. Mavis, 1955 Proceedings AISE.

2. *"Temperature Stresses in Iron Work Rolls,"* by Charles F. Peck, Jr., Juan M. Bonetti, and Frederic T. Mavis, 1954 Proceedings AISE.

By K. R. KESKA, Assistant Chief Engineer, Wean Equipment Corp., Cleveland, Ohio

Developments in shot blasting strip steel

Present indications show that shot blast cleaning equipment has a very definite place; particularly on hot rolled pickled steel, which is to be later coated with paints, oxides or metallic coatings.

▲ BEFORE discussing recent installations of blasting equipment and the advantages which the users expect to gain from these installations, it might be well to, first, define mechanically descaling or shot blasting and cover some of the early history of shot blasting operations on flat rolled products.

Mechanical descaling or shot blasting is an airless principle where shot is hurled at high velocity on the work using centrifugal force to motivate the shot. The method used in small foundries, of air blasting round steel pellets against castings to clean off scale and sand is a well known process. However, in an operation where a large surface is to be cleaned, the amount of shot necessary to provide a clean surface, when carried by compressed air, makes such an operation prohibitive due to the cost of the compressed air. Today, centrifugal blasting is the accepted practice for commercial use including the cleaning of castings, forgings and rolls, as well as flat rolled products. The shot discharge from the blasting wheel is controlled to a definite pattern in order to be able to concentrate the area of cleaning and to reduce the wear on the enclosing cabinet.

Early abradants or shot used in the period around 1935 consisted of chilled cast iron particles, sand, and refractory materials. Most of these early abradants had a tendency to imbed in the surface of the material being cleaned or would break down and leave a deposit on the surface of the product.

At the present time, there are five types of shot in current use. These are as follows:

1. *Cast iron shot*—This has a Rockwell "C" hardness of 62 to 64, and is very brittle, it breaks up rapidly, and causes excessive wheel wear. However, it cleans at an extremely fast rate.
2. *Cast iron grit*—This is the same consistency as mentioned above except that it is crushed iron shot of smaller size, having sharper corners and edges.
3. *Malleablized iron shot*—This has a Rockwell "C" hardness of 40 to 45. This shot is tough rather than brittle and is a little slower cleaning.
4. *Steel shot*—This has a Rockwell "C" hardness of 40 to 45. The shot has properties which make it extremely tough in withstanding repeated impact more than any of the other previously mentioned shots.
5. *Clipped wire*—Clipped wire shot is made by clipping hard drawn steel wire into extremely short lengths. This shot provides the toughness of the steel shot and, also, the sharp, fast cleaning edges of the crushed type shot.

BRIEF HISTORY

In 1936 a patent was issued to R. J. Wean entitled, "Coated Sheet Metal and Process of Making Same." In 1940 a patent was issued to Ralphe K. Clifford entitled, "Process for Cleaning Metal Surfaces." Both of these patents dealt with the mechanical descaling or cleaning of sheet material for the principal purpose of making culvert stock. Culvert stock is 11 to 20 gage material which is hot dip coated, usually zinc, and then corrugated and rolled into a cylindrical shape for imbedding in earth or concrete. The first patent also covered the continuous cleaning of strip material prior to a metallic coating.

The first shot blast descaling machines for sheet passed the sheets through the machines in a vertical plane, as shown on Figures 1 and 2. These early machines had the advantage of having the shot impinge on the sheet in a horizontal direction so that it would drop off into the recovery box. There was a minimum carry-over to contaminate the further processing of the material.

Culvert machines of the types shown on these slides are still in operation in plants of the Gary Sheet and Tin Mill, Republic Steel, Continental Steel, and Wheeling Steel.

The operation at Gary consists of first shot blasting the material and then giving it a five-minute pickle as a final clean-up. If the material is not blasted, it must be pickled from fifteen to twenty minutes to provide the proper surface for coating. Also, Gary has experimented with complete blast cleaning, eliminating the pickle. They have found that complete blast cleaning leaves irregular holes in the surface which are deep and uneven. In further processing, an uneven coating results in a poor product. Also, by having deeper impressions in the surface of the material, more zinc is used which of course is more expensive.

At the present time, the existing culvert stock machines are being replaced by heavy gage continuous hot dipped galvanizing lines. The reason for this is the economy encountered by producing strip material over sheet material and a more uniform coating.

In 1935 the Gary Sheet and Tin Mill installed a shot blast cleaning unit in the 36 in. pickle line. This line had

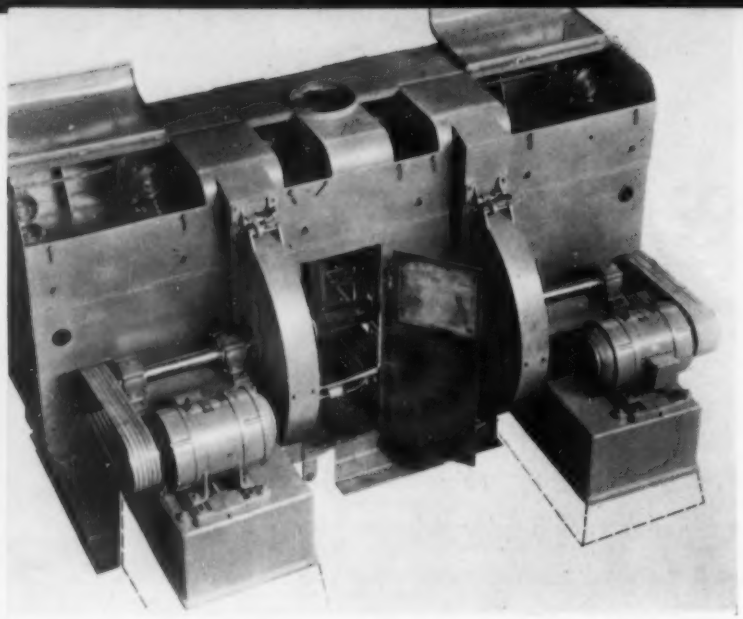


Figure 1 — Sheets pass through this machine in a vertical plane.

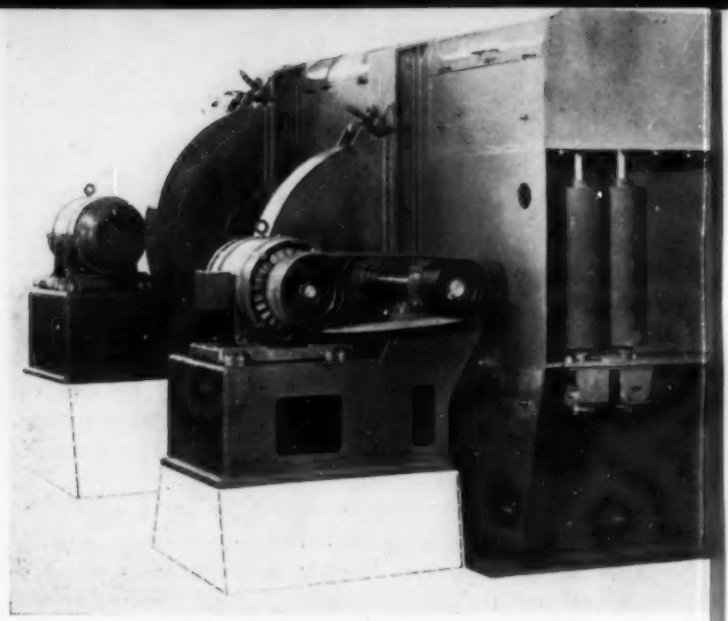


Figure 2 — This type of machine had an advantage in that the shot dropped off resulting in a minimum carryover

three 60-ft acid tanks and operated at a speed of 50 to 60 fpm. The shot blast cleaner had one abrasive wheel above and one abrasive wheel below the strip.

In actual operating tests it was shown there was no appreciable difference in the pickle time required to clean the strip, whether the strip was blasted or not. In further tests it was found that to show any appreciable results in blasting, the line speed had to be reduced to 6 fpm and the strip given a subsequent pickling pass to remove the surface scum and rolled-in scale. Since the line was designed for straight pickling at 60 fpm, and no appreciable difference in pickle time was encountered with the blasting, the blasting operation was abandoned.

However, at this early date, it was established that there existed a balance between the amount of blasting and the amount of pickling required to produce a satisfactory product at increased speeds and efficiencies.

In 1935 the Crown Cork and Seal Co. installed a blast cleaning line. There were two reasons why Crown Cork and Seal decided to install blast cleaning equipment. First, they were having considerable trouble with hydrogen and moisture inclusions in the hot rolled steel they were purchasing. These inclusions would cause blisters when the material was coated and subsequently heated. Secondly, in Baltimore, Crown Cork and Seal had no acid disposal equipment and could find none available for their use. The line, as it was installed, is shown on Figure 3. It consisted of the following equipment:

a. Processing uncoiler for uncoiling and flattening the material.
b. Stitcher for joining the end of the new coil to the tail of the preceding coil.
c. Pinch roll with looping pit so that the processing section could run continuously.
d. Drag pinch roll for holding tension through the subsequent three blasting cabinets.
e. Exit pinch roll.
f. Crop shear for cutting out the stitches.
g. Scrubber for cleaning the surface.
h. Dryer.
i. Upcoiler.

A short time later, it was found necessary to add a short dip pickle to remove surface dust and rolled in scale not removed by the blasting equipment. Shot blast cleaning equipment will remove surface scale but will not remove imbedded or rolled-in scale or dirt.

This line was used to clean hot rolled steel which was then further processed to produce tin plate for subsequent manufacture into tin cans and bottle caps. The centrifugal wheels used in this machine had about one-fifth the capacity of present day wheels. This line successfully cleaned hot rolled steel for subsequent rolling into tin plate for about one and one-half years after this time; the operation was discontinued for two reasons:

1. During further processing, the operators of the rolling mills complained of microscopic dust or particles imbedded in the surface of the material. These particles could not be brushed off or felt with the hand. It was later learned that these particles were bits of chilled iron which had imbedded themselves into the strip surface. Crushed chilled iron was used for the abradant in this installation. At the present time, steel shot accurately sized is used as the abradant and no imbedding is being experienced by present day users.
2. Previous to the installation of the shot blasting equipment, Crown Cork and Seal had been paying an extra of $6.00 to $7.00 per ton for pickled hot rolled steel suitable for further cold reducing into tin plate gages. A large steel producer offered Crown Cork and Seal a contract to provide the required quantity of pickled hot rolled steel at a cost far below the above figures. Crown Cork accepted this contract and discontinued the shot blasting operations.

From 1935 until approximately 1950, very little was accomplished in the matter of shot blast cleaning of flat rolled products, except for an installation made by Dominion Foundry and Steel in Canada. These people had been operating a pickle line at approximately 110 fpm, and were having considerable trouble removing scale. However, this pickling job was an extremely

tough one due to the fact that Dominion produced their hot rolled material on a reversing mill. The temperature of the material would continue to drop on succeeding passes through the rolling mill. Upon analysis, it was found that there were five different kinds of scale on a single trip of material processed on this mill. Dominion found that a combination of scale breaking and shot blasting and then pickling gave good results.

A test was run on the Dominion machine, giving the strip a double pass at 40 fpm through the shot blast equipment which, in essence, means that the material was processed through a shot blaster continuously at an average rate of 20 fpm. This material was successfully rolled into tin plate. However, this was a test operation and only a few coils were run.

Since that time, Dominion Foundry and Steel have installed a complete new hot mill and have since abandoned the shot blast equipment, as it is no longer required.

In a recent demonstration, 40 coils of material were cleaned by double blasting test. Double blasting is a process of passing the material through two shot blast machines; the first machine, using a large size shot to break up the scale, and a second machine, using a fine shot to clean the strip. These coils were then further processed into tin plate and cold rolled products. These tests proved that all scale could be removed and salable hot dip and one-half pound electrolytic tin plate could be produced. It was determined during these tests that strip with a coating of scale dust could not be rolled in a reversing cold mill. Thus, it is necessary to scrub or wash the strip after blasting in order to have material suitable for further processing. It has been proven in further tests, that this dust can be removed by hot water scrubbing to a degree where a white handkerchief will not be discolored when rubbed over the surface.

DESCRIPTION OF BLASTER

The present day blast cleaning machine is composed of the following principal assemblies:

1. The blast cabinet which encloses the wheels and retains the shot.
2. A number of driven vane type wheels to provide uniform blasting intensity across the surface to be cleaned.
3. An abrasive handling system to recycle the used shot.
4. Abrasive cleaning equipment to remove all non-abrasive and broken shot during each cycle.
5. Work carrying or supporting conveyors.
6. Exhaust and dust collector systems.
7. A high pressure blower to blow abrasive off top surface of work, to prevent carryover.

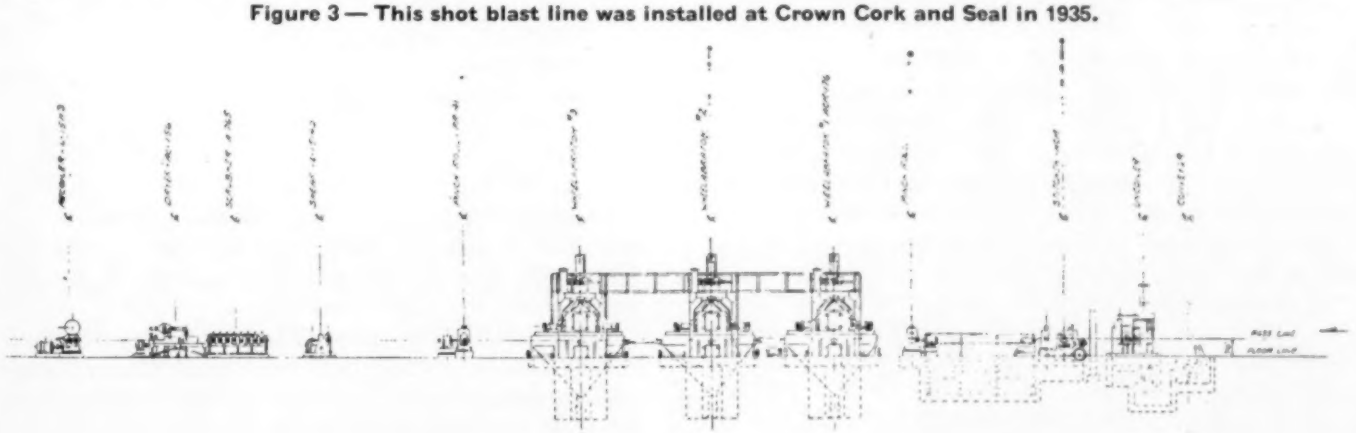
The heart of the blasting machine is the wheel itself, which consists of the runner head equipped with radial throwing vanes driven by an electric motor. The abrasive is fed into the center of the wheel on to the inner tips of the vanes. The abrasive is thrown into space by the velocity of the rotating wheel. The abrasive leaves the wheel in a confined segment of discharge and spreads in a fan-shaped pattern. The segment of discharge is controllable.

The width of blast pattern is equal to the width of the wheel. Abrasive intensity is uniform across the width of the pattern. The lengthwise intensity varies with the length of the pattern. This is an inherent defect in centrifugal blast wheels. The length of the pattern increases with the distance between the work and the wheel. Also, the abrasive intensity per square inch of work surface decreases as pattern length increases.

In the blast cleaning of flat rolled products, non-uniform intensity throughout the blast pattern must be considered. If the blast pattern is parallel with the movement of the work, the pattern will be narrow, but the work will pass through all zones of variable intensity and be blasted uniformly through the entire width of the pattern. If the blast pattern is transverse with the movement of the work, one part of the work surface will receive a heavy blast while another part of the work surface receives a lighter blast due to various intensities in the length of the blast pattern. For cleaning flat rolled products, the usual procedure is to operate two wheels as a team; one operating clockwise, and the other counter-clockwise, each wheel throwing its abrasive on the same length of the blast pattern. The total blast pattern is then approximately uniform in intensity throughout the length of the combined pattern, therefore, blasting the product uniformly.

For efficient blast cleaning, the angle of impact of abrasive on the work is very important. Most of the present day shot consists of round balls which, when projected against the flat surface at a 90 degree angle, will rebound in the same path that was originally pro-

Figure 3 — This shot blast line was installed at Crown Cork and Seal in 1935.



jected. Such an impact angle will cause abrasive collision with the resultant pile-up of abrasive on the sheet surface. Because of this condition, abrasive wheels are mounted so as to provide an angle of impact which varies from 15 to 25 degrees off the vertical, causing the shot to rebound out of the path of the following shot.

All parts of the blast wheel, including the vanes and housings, are all subject to complete destruction. Each of these parts have respective useful lives influenced by the quantity and quality of the abrasive handled. The inside of the blast cabinet is protected with sectional replaceable wear plates where the surfaces are directly in line of the blast stream.

The abrasive does all the work and to maintain maximum production, the abrasive should be kept constantly cleaned and of the correct size. Each time the abrasive is projected against the work, it is gathered and passed through an abrasive separator to remove broken down abrasive and scale.

An exhaust system, operating in the blast cabinet, removes dust and scale particles from the air and prevents the dust from leaking out of the cabinet.

RECENT INSTALLATIONS

Since 1951, various manufacturing plants and steel producers have made installations of shot blast cleaning equipment.

The U.S. Steel Homes Division of the United States Steel Corp. has recently installed shot blast cleaning equipment. U.S. Homes is the old Gunnison Homes Division, which manufactures all metal houses. This line is set up to process hot rolled material 42 in. wide ranging in gage from 0.048 in to 0.125 in., in coils of 50-in. diam, weighing up to 15,000 lb. The line is designed to operate at from 50 to 100 fpm and consists of the following equipment:

a. Overhung mandrel type uncoiler with coil car.
b. 5-roll flattener.
c. Crop shear.
d. Hand welder—this is a hand butt weld operation.
e. Blast cleaner.
f. Oiling machine.
g. Crop shear.
h. Overhung mandrel type recoiler with coil discharge car.

The U.S. Steel Homes Division also operates a separate slitting line and a flying shear line incorporating a guillotine flying shear for processing of the cleaned material.

The Rome Cable Corp. in California, who are manufacturers of electrical conduit, have recently installed a blast cleaning line. The line is for processing material which is subsequently made into conduit ranging from ½ to 2½ in. in diameter. The line set up to take strip material 36 to 48 in. wide, gages from 0.109 to 0.154 in. The line operates at a speed of 80 fpm and consists of the following equipment:

a. Uncoiler.
b. Flattener.
c. Blast cleaner.
d. Slitter.
e. Recoiler.

The blast cleaner in this line has an overall length of approximately the following:

Rome Cable made this installation after a study and in consideration of the following:

1. Hot rolled steel is much more available than is pickled steel. Also, as is natural, the unpickled hot rolled costs less than the pickled product.
2. Acid pickling of the hot rolled product was discarded because of the high cost to operate a minimum pickling installation and the large plant area or floor space required for such an installation.
3. On a small scale, low production operation they believed they could, and have subsequently proved, that they can shot blast descale for less than it would cost to pickle the product.
4. The shot blast cleaned surface is a matted surface which is ideal for a tight zinc coating.
5. The cleaning action can be stopped or started at will. This is not so in a pickling operation where tanks must be brought up to temperature and held at a temperature, in order to provide an efficient pickling operation.
6. Under actual operating conditions, Rome Cable claimed that they have no loss of virgin metal by using shot blast cleaning. Under standard pickling procedures, it has been estimated that about 1½ per cent of the virgin metal is lost in the process.

After the line had been installed and in operation, these people found that they could operate a four-wheel machine for about $2.73 per hour. This is a cost per ton of about 60¢, which is about 30 to 40 per cent less than for what they could purchase the comparable pickled product.

The Allegheny Ludlum Steel Corporation at Brackenridge, Pa., has installed a blast cleaning and pickling line for cleaning all grades of hot rolled stainless steel. The material is 0.095 to 0.1875 in. thick for hard stainless, and up to 0.240 in. thick for soft material. Coils are 15,000 lb and 37 in. wide. This line operates at speeds from 30 to 75 fpm and produces six tons per hour. The entire line takes up a space 20 ft wide by 300 ft long. The line consists of the following equipment:

a. Uncoiler.
b. Flattener.
c. Punch and rivet machine—for joining the tail of one coil to the leading edge of next coil.
d. Blast cleaning machine.
e. Two acid tanks—one containing 16 per cent sulphuric acid at 185 F and the second containing 17 per cent nitric acid at 150 F.
f. Cold water dip tank.
g. High pressure spray box.
h. Hot water rinse tank.
i. Pinch roll.
j. Crop shear.
k. Recoiler.

Incidentally, Allegheny Ludlum also operates a second blast cleaning line similar to the above, on silicon steel. This line is rated at 13½ tons per hour and 150 fpm.

Prior to installing these lines, Allegheny Ludlum has been batch pickling both these products. In a comparison against the old process of batch pickling, they claim the following advantages:

1. They have reduced the manpower from 24 men required to operate the batch pickler to 5 men required to operate the blast cleaning line.
2. The blast cleaning line occupies about 50 per cent less floor space than the batch pickling operation, about 6,000 sq ft compared to 10,500 sq ft.
3. The maintenance on the blast cleaning equipment is far lower than the batch pickler.
4. The quality of the cleaned product is more consistant and greatly improved over the batch pickling method.
5. Working conditions for the operators are safer and much more pleasant.
6. They have completely eliminated the necessity for scale breaking straight chrome grades of stainless prior to cleaning and pickling. This is a very important point and by far the biggest savings in the operation. Under the system of batch pickling, it was necessary to take a 1 to 2 per cent reduction, in order to get a satisfactory pickle. Cold reducing the material before pickling caused considerable surface damage to the material itself and, also, caused high maintenance on mill rolls.
7. The weight loss, due to cleaning and pickling, is now well under 1 per cent whereas under the old batch pickling operation, 2 per cent of the material by weight was lost in the pickler.
8. Cabinet maintenance is held to a minimum. The inside of this cabinet is provided with removable wear plates which absorb the beating of the shot ricocheting off the strip. These plates are given a daily inspection which requires about five minutes. If the plates must be replaced, this can be done manually and requires about thirty minutes.
9. Far less crane service is required in the operation of the combination blast cleaner and pickler, as compared with the batch pickler.

ous maximum of 250 fpm. The entry end coils are 10,000 lb and the exit end coils are 25,000 lb. The strip gage is 0.050 to 0.250 in. The line consists of the following equipment:

a. Processing uncoiler.
b. Crop shear.
c. Space alloted for a future automatic butt welder.
d. Stitcher.
e. Pinch roll.
f. Looping pit.
g. Pinch roll.
h. 16-Wheel blast cleaning unit.
i. Roller conveyor—covering the space alloted for future pickle tank, if required.
j. One 60 ft acid dip tank.
k. Hot and cold water rinse tanks.
l. Dryer.
m. Exit looping pit.
n. Pinch roll.
o. Crop shear.
p. Side trimmer and scrap chopper.
q. Upcoiler and coil conveyor.

The Empire Steel Corp. is not a large tonnage producer. They produce from 30,000 to 40,000 tons per month, which means from 15,000 to 20,000 tons of low carbon and 15,000 to 20,000 tons of silicon each month.

There were several factors which influenced Empire into their decision to install shot blast cleaning equipment. They needed more cleaning facilities, but they had to reduce, if at all possible, the use of acid and the problem of its disposal. Acid disposal to Empire is a tremendous problem since the plant is located on a river which furnishes the water supply to Mansfield, Ohio. They cannot afford to have seepage from waste pickle liquor disposal pollute the stream furnishing the water supply. Also, they have no land available on which to dispose of the waste pickle liquor by dumping

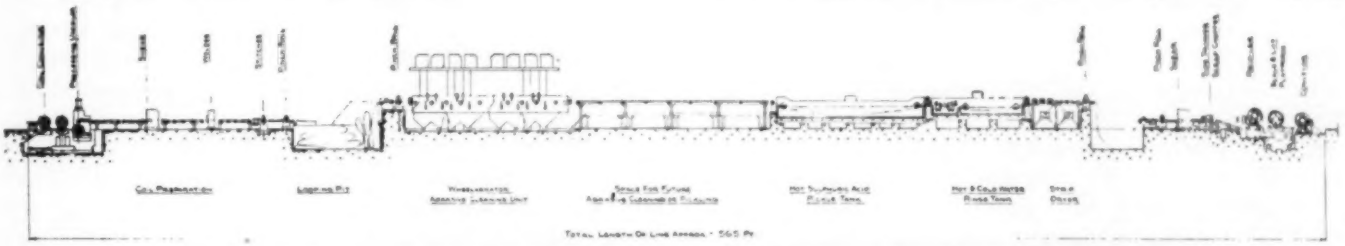


Figure 4 — This line will handle hot rolled low carbon and silicon steel in widths of 20 to 44 in.

After operating these lines for some time, Allegheny states, in a published cost comparison, that the stainless line operates for about 65 per cent of the cost of pickling low carbon steel and that the silicon line operates for 85 per cent of the cost of pickling low carbon steel. These costs are presumably based on lines of equal capacity.

The Empire Steel Corp. of Mansfield, Ohio, is just completing the installation of a combination blast cleaning and pickle line, to handle hot rolled low carbon and silicon steel. Empire Steel will run about 50 per cent low carbon and 50 per cent silicon on this line.

The line, as shown on Figure 4, is for handling material 20 in. to 40 in. wide at a processing speed of 250 fpm. The entry end equipment operates at a maximum of 500 fpm to keep the processing speeds at a continu-

and neutralizing. With this installation, however, they do not hope to be able to completely eliminate acid pickling entirely, since, as was mentioned previously, the deposit on the blasted strip and rolled-in scale is extremely detrimental to the further cold reducing of the cleaned product.

Another very important point in the consideration of the choice of equipment to be installed was the size of the existing steam generating plant. They did not want to increase the size of this plant in order to provide the necessary steam to operate a larger pickling plant. At the present time, the generating plant is operating at near maximum capacity.

Empire estimates that they will be able to shot blast descale for about 46¢ per ton. To this must be added the cost of operating the other equipment in the line.

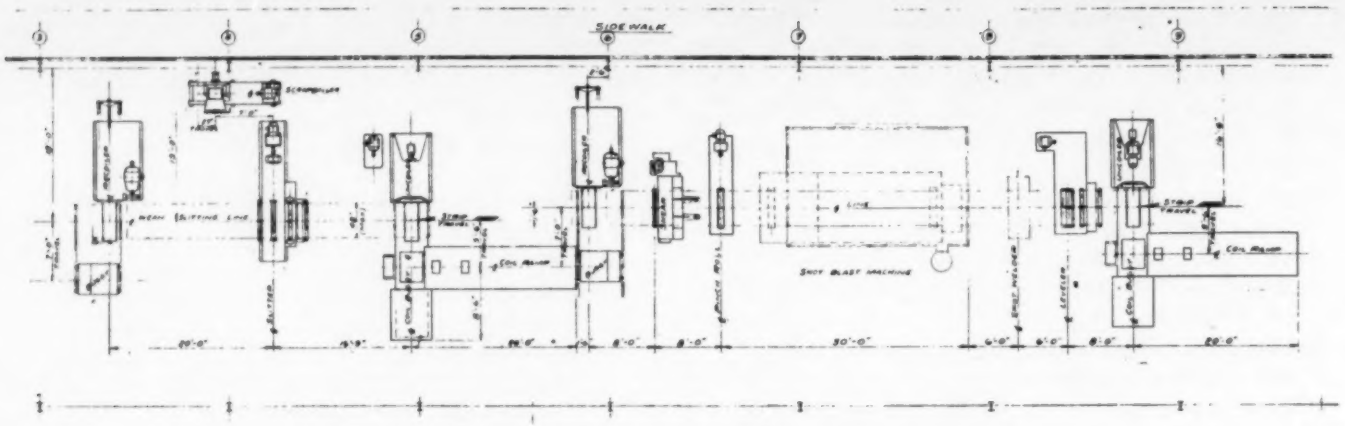


Figure 5 — This line operates at speeds from 25 to 75 fpm.

The blasting equipment installed in this line has 16 wheels, each of which is capable of hurling 1000 lb of shot per minute on the strip at speed of abradant of 15,000 fpm. For matters of comparison, a modern high speed, high production pickle line installation operates at a total cost of $1.50 per ton. However, lower speed, smaller production lines operate at higher costs. There are three items in the total overall operating costs of a shot blasting machine. These are: the cost of shot, the power consumed, and maintenance. Average cost for replacement parts of a shot blast machine will average approximately 50¢ per wheel per hour so that the maintenance can be a large item in the operating costs of this type of equipment.

There is much interest in the results to be obtained from this line, particularly with respect to the blast cleaning and subsequent pickling of low carbon steel, from the point of view of increasing the speeds of existing pickling lines by the addition of blast cleaners.

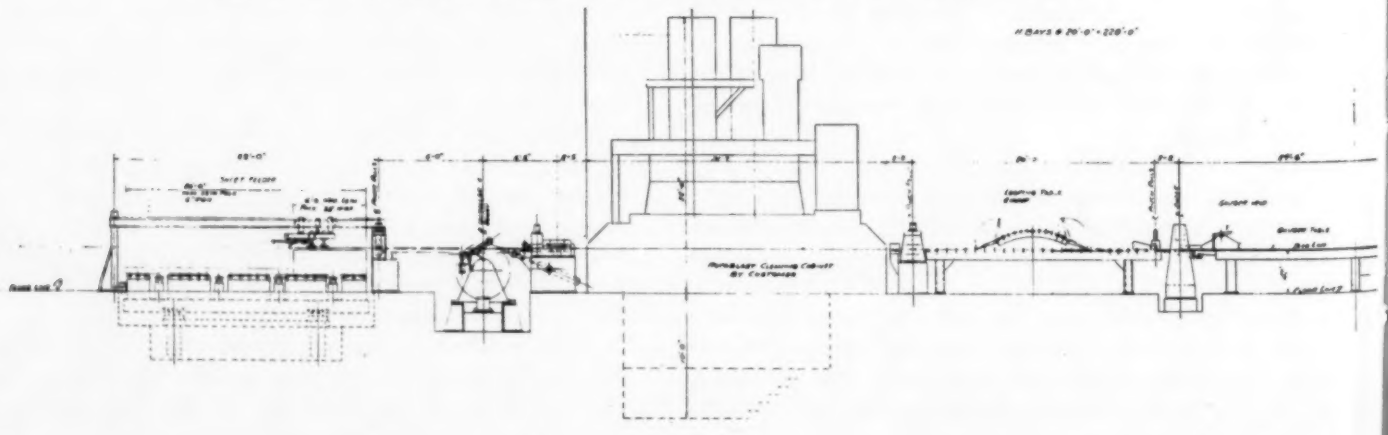
Some experimentation has already been completed in this direction. One large steel producer shipped a number of coils to Allegheny Ludlum. These coils were subsequently shot blast cleaned and pickled on Allegheny's silicon steel line. They were then returned to the producer who cold reduced them and produced satisfactory tin plate. The cold rolling was done on a 4-stand tandem mill. This producer performed these experiments in order to determine if it was possible to add shot blast equipment to minimum speed existing pickle lines, in order to increase their production to equal that of the high speed lines now in operation. The product produced from these experimental coils was proven satisfactory from every point of view. However, when a cost analysis was made to determine the size of the blast equipment necessary to provide the added speed, it was found that the size and cost of operation of the blasting equipment became excessive, increasing so much that it was more economical to build and install additional pickling facilities rather than to install blast cleaning equipment in the existing lines.

As an example, for comparison purposes, each of the 16 wheels on the Empire blast cleaning unit is driven by a 40-hp, a-c motor which, when added to the auxiliary drives for separators, elevators, etc., gives the unit a total aggregate horsepower of approximately 700. This 700 hp is for the blast cleaning unit only and is in addition to all the other power required to operate the handling equipment and the pickle line proper.

The Steel City Electric Co. of Pittsburgh, Pa., who are makers of outlet and junction boxes and various conduit fittings for the electrical industry, have recently purchased a shot blast cleaning line for handling 0.060 to 0.1875 in. hot rolled steel, 48 in. wide, in coils weighing up to 20,000 lb. The line is to operate at speeds of 25 to 75 fpm and consists of the following equipment, as shown in Figure 5:

a. Entry coil ramp.
b. Overhung mandrel uncoiler with loading buggy.
c. 5-Roll flattener with coil end peeler.
d. Blast cleaning unit.
e. Pinch roll stand.
f. Recoiler with coil car.

Figure 6 — Schematic shows details of one of the newer shot blast cleaning lines.



The coil car from the blast cleaning unit discharges the cleaned coils on to the coil ramp of a slitting line where the material is slit to meet production's needs. Please note that there is no washer, spray unit or scrubber in the blast cleaning line. The material is eventually cleaned before being plated but after forming into the various parts. At present, Steel City is paying $30.00 per ton extra for pickled and oiled stock. From their estimated cost survey, they expect to be able to operate the blast cleaning line for about $9.00 per ton or a savings of $21.00 per ton. Material is about two-thirds of the total cost of the product produced, any savings in the cost of the material is a large percentage reduction in the cost of the product. This customer expects to retire his entire investment in less than two years, directly from the cost savings in material alone.

Upon investigating blast cleaning, Steel City discovered that the hot rolled blasted product had slightly better qualities for forming and drawing than did the hot rolled pickled product. They also found that shot blasting for descaling increased the surface hardening of the strip from three to four points on the Rockwell "B" scale. However, this is not a detrimental factor in the forming or drawing of the material for the product. These people expect to lose 2 to 3 per cent by weight of the purchased hot rolled steel due to the shot blasting of the material. This would be scale loss. Another important factor to consider in this particular installation is indirect savings. It is well to point out here that most of the indirect savings can be attributed to the slitting operation rather than to the shot blast operation, although the purchase of wide material for shot blast cleaning saves a considerable amount of money over the purchase of narrower pickled and oiled stock. This customer expects to obtain the following indirect savings; smaller inventory of material necessary to meet production requirements, a more efficient use of material due to better planning of the slitting operation, less material handling due to the straight line run from shot blaster to slitter, and less storage area required for raw inventory due to large coils which can be stacked together.

Another recent purchaser of shot blast cleaning and auxiliary equipment is a large fabricator for the automobile industry. This customer is planning to handle coil, sheet, and plate material in a combination shot blast cleaning and shearing line. The material to be handled will meet the following specifications:

Gages—0.055 to 0.187 in. for coiled material.
0.055 to 0.299 in. for sheets.
0.299 to 0.375 in. for plate material.

Material will range in width from 19 to 60 in. for all three classes of material.

Coil weights—23,000 lb.

Pack weight for sheet and plate material—23,000 lb.

Pack lengths on the entry end are 6 to 20 in. long and on the exit end 3 to 20 in. long.

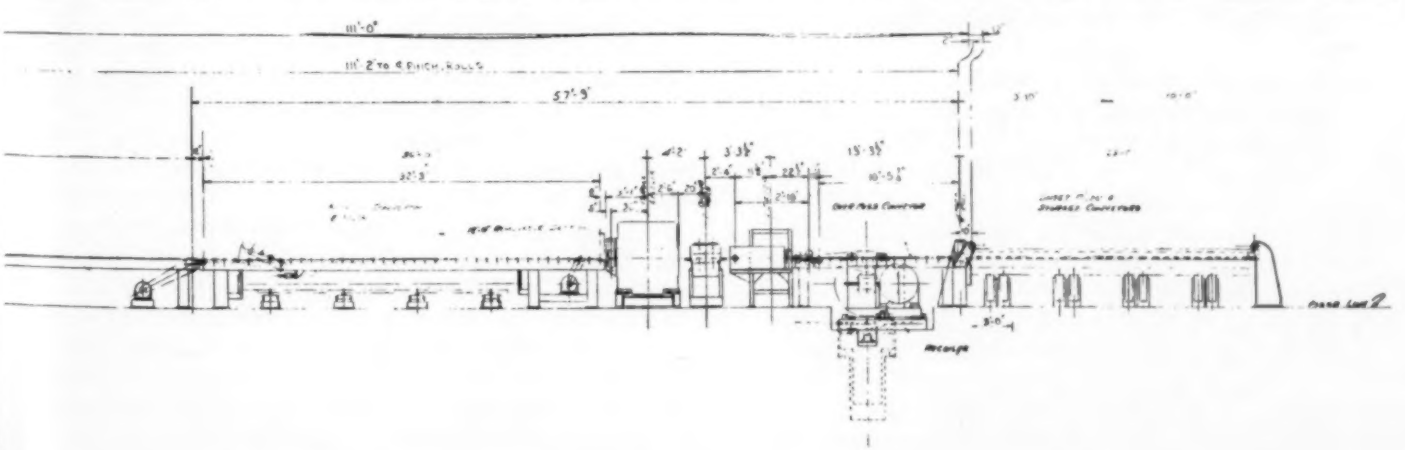
The shear in this line operates at 24 cuts per minute in $\frac{3}{16}$ in. thick material.

The speed of the line is 40 to 160 fpm, and the feeder capacity is $\frac{1}{4}$ in. x 60 in. x 20 ft long or $\frac{3}{8}$ in. thick x 60 in. wide x 15 ft long.

The line is shown on Figure 6 and consists of the following equipment:

a. Entry pack conveyor.
b. Sheet feed table with sheet feeder.
c. No. 1 pinch roll.
d. Uncoiler crossover conveyor.
e. Uncoiler with coil car and storage rack.
f. 5-Roll flattener with coil end peeler.
g. Shot blast cleaning unit.
h. No. 2 pinch roll.
i. Hump table.
j. Upcut shear.
k. Gager head and table with automatic stop set up for cropping leading ends of strip.
l. Conveyor and scrap deflector.
m. 17-Roll leveler.
n. Oiler and spray cleaner using cleaner at high press up and high temperature.
o. Recoiler with coil car and discharge ramp.
p. Recoiler overpass conveyor.
q. Piler.
r. 2-Way pack conveyor.

This customer has based the purchase of this equipment on two direct labor and material savings; a pickling cost savings of 3¢ per cwt of material purchased and a shearing savings of 14.35¢ per cwt. From these two savings, this customer expects to write off the initial investment in 12 to 14 months. For indirect savings, which are not included in the cost survey the customer expects the following: greatly reduced material handling especially for long heavy plates, greatly reduced material storage due to the reduction in the number of sheet packs necessary, lower inventory due to the fact that any size sheet can be cut from coil, added die



life, less die maintenance, and easier sheet separation for feeding into forming and blanking presses due to the lubrication of the sheets.

Before proceeding with the purchase of this equipment, this customer purchased 16 coils or about 300,000 lb of hot rolled pickled material, which he had cut on a hump table type cut-up line by the steel supplier. This experiment was run in order to check the temper and gage of the end, center, and tail of the coils. This was done because the customer has a very minimum of scrap loss in his manufacturing process. Scrap ends, die skeletons, and drop-offs are converted to small parts. This processing of hot rolled pickled material proved extremely successful, meaning that as rolled-hot rolled steel, when cleaned, could be made into a salable product.

This customer will abandon a very efficient batch pickling operation. As can be seen from the above, he expects to save only 3¢ cwt over his present pickling operation. Also, the customer at present does not have a waste pickle liquor problem, although he might have in five or ten years. He presently dumps his waste pickle liquor into deep wells where the seepage as yet has not affected water supplies or contaminated neighboring streams.

For purposes of general comparisons, the following is a tabulation of a few cost comparisons which have been published; for 16 and 18 gage sheets mechanical cleaning costs approximately $2.80 a ton and pickled material about $4.00 per ton. The above is for actual mechanical cleaning against the extra for pickled material. For 16 and 18 gage sheets, including other equipment in the line and overhead and depreciation based on 17 tons per hour, mechanical cleaning ran approximately $2.83 a ton and pickled stock $6.00 to $7.00 a ton extra. For 14 gage to ¼ in. sheets and plates, including overhead and amortization, mechanically cleaned sheets cost about $1.80 per ton and pickled and oiled sheets about $7.50 a ton extra. On a strip application, mechanically cleaned sheets ran $1.90 to $2.00 a ton while pickling cost $3.75 to $4.00 a ton. It is assumed that these costs are on comparable bases.

SUMMARY OF GAINS OR ADVANTAGES OF BLAST CLEANING

To summarize, the advantages which various users or future users expect to gain from blast cleaning equipment are as follows:

1. A roughened surface matte which is ideal for coating with zinc, lead or other metallic substances, paint, or various oxides.
2. A base material which is free from hydrogen and moisture inclusions caused by pickling, which, in subsequent operation, will cause blisters in the finished coating of these materials when the material is subjected to further heating.
3. Recovery of all steel removed by the blast cleaner.
4. Recovery of shot used for descaling for future separating and reuse.
5. The blast pattern in any blast cleaning machine can be controlled so that when running narrow strip, the pattern can be concentrated and, therefore, the same blast coverage can be given to a narrow strip at higher speed, as can be given to the wider strip at the slower speed. In blasting, speed in any installation is directly proportional to the area being cleaned. This is not so in a pickle line where, regardless of strip width, the line speed is held constant for any given thickness and scale condition.
6. Cleaning can be done with a blast unit on a basis of current needs since there is no operating expense on the blast cleaning unit during the period when it is shut down. The line can be operated intermittently with no injury to the product or the equipment. Such is not the case in pickling, since due to the cost in raising the temperature of the tanks and keeping the acid concentration at the proper operating levels.
7. Blast cleaning operation is a dry operation. No water is required except in such scrubbing and cleaning equipment as is required to remove the surface dust.
8. It completely eliminates the acid disposal problem when used exclusively or it minimizes or keeps to a minimum the acid disposal problem when used as a combination line since very little pickle is needed after blast cleaning. This is a very important point to the small or relatively small steel user.
9. If desired, it is possible to operate a blast cleaning line without stitching, welding, riveting or joining equipment. However, such an operation requires more threading time.
10. A blast cleaning installation requires less floor space than a pickling set up as the blast cleaning unit is relatively small.
11. The capital investment in the blast cleaning unit is relatively small.
12. The weight of material lost in this operation is well under 1 per cent and consists almost entirely of scale removed, where in an efficient pickling operation, at least 1½ per cent of the virgin metal is also lost.
13. There are some qualities in the blast cleaning of strip which are very advantageous in the forming and drawing of the material which are not evident in straight pickled stock.

CONCLUSION

At the present stage of development, it seems reasonable to conclude that blast cleaning will *not* replace pickling as a method of scale removal where the material is to be cold reduced.

Acid pickling produces a cleaner product at higher production rates and lower operating cost, especially in high speed mass production operations.

The above does seem to indicate, however, that shot blast cleaning equipment has a definite place in the operations of those manufacturers who, at the present time, use hot rolled pickled steel and especially those who later coat their products with paints, oxides or some type of metallic coatings.

It has only been since 1950 that any real activity has been evident in the field of shot blast cleaning, with reference to flat rolled products. It appears that the surface has only been scratched as far as applications of this type of equipment are concerned.

Babbitt's Contribution to Reserve Mining Company's taconite operations

By ROBERT J. LINNEY

Manager of Operations, Reserve Mining Co., E. W. Davis Works, Silver Bay, Minn.

. . . . Babbitt produces a concentrate which runs from 80 to 85 per cent – 325 mesh and has an average of 64.5 per cent Fe . . . . this is then processed in a pelletizing plant . . . .

▲ THE mining operation of Reserve Mining Co., jointly owned by Republic Steel Corp. and Armco Steel Corp., is located at Babbitt, on the easternmost end of the Mesabi range in St. Louis County, Minn. The ore body, consisting of magnetic taconite, is approximately nine and one-half miles long, extending in a southwesterly direction and has an average width of 3000 ft. It is wedge shaped in cross section ranging from 20 ft thick at the north pit limit to 180 ft thick at the south pit limit. The formation strikes S 60 degrees W and dips to the southeast at 5½ degrees. The top of the taconite is very rough and irregular and is covered with a shallow layer from 2 to 20 ft of glacial drift with outcroppings to the surface in many places.

This property, leased by Reserve in 1939, was relatively unexplored except for about two miles near the eastern end where drilling was confined to around 50 ft of depth, and some scattered inconclusive drilling recorded along a mile of formation at the extreme western end of the property. In order to gain a better knowledge of the formation in general, a survey was undertaken in 1945 to locate, classify, sample and map all outcrops that could be found on the property. After correlation of these findings, a diamond drilling program was conducted in the fall of 1946 and summer of 1947. This program was designed to obtain a working knowledge and understanding of the iron formation and to substantiate information acquired from previous work. A series of holes were drilled at predetermined intervals along the full length of the property to determine the character, grade and width of mineable formation with regard to pit layout and development.

Several holes were drilled in previously drilled areas to supplement and check the older drilling and to locate igneous intrusions and effects of the Duluth gabbro on the formation. Most of the holes were terminated when reaching the lower slaty member. All of the drill core was split in two, one-half was crushed and analyzed by the Davis magnetic tube test and the other half was classified and stored in order.

With this information at hand along with other pertinent data, a proposed pit outline was established and a calculation of estimated mineable reserves and analysis was made possible.

In the establishment of the mining outline or proposed pit limits, the south boundary was drawn in order to eliminate any possible rock stripping and the north boundary was held to a minimum bench of 20 ft of upper cherty formation.

Within these pit limits, composed chiefly of upper cherty formation and a small portion of the lower part of the upper slaty formation, an estimated 1,500,000,000 tons of taconite averaging between 23 and 24 per cent magnetic iron is waiting to be mined.

These large tonnages of Eastern Mesabi taconites, though the first to be discovered on this range by the early prospectors, were the last to be given consideration. This is primarily due to the stubborn characteristics of this hard and dense iron bearing rock.

Taconite has been described as any low grade iron formation, but the big difference between this taconite and many of the others is its extreme hardness reported to be in the neighborhood of 600 Brinell and believed to be the result of contact metamorphism of the iron formation by the Duluth gabbro. It was the stubborn physical characteristics of this taconite that defeated an attempt by Mesabi Iron Co. in the early 1920's to mine and process a commercial product.

Much has been done in the ensuing years by Reserve, in cooperation with other companies, to develop equipment, means and methods for mining and preparing this taconite to be delivered to the crushers.

The first and most important obstacle to overcome in mining this tough taconite was to be able to drill at a reasonable speed and cost to maintain large production. Conventional methods of drilling used in the past were

prohibitive. Churn drills, the most popular means of drilling blast holes, produced only 10 or 12 ft per shift and bit changes had to be made every 6 to 12 in. of drilling.

In 1946 the first experimental vertical blast hole flame piercer was brought to Babbitt for test drilling taconite. These tests were continued through the summer of 1947 with a vigorous program of process and design changes which led to the development of the present jet piercing machine.

Reserve has been using this jet piercer for all of its blast hole drilling for the past two years with considerable success.

The technique used in piercing is a combination high velocity, high temperature flame produced by combustion of liquid petroleum fuels (kerosene or diesel fuel) and gaseous oxygen in the burner chamber at 150 psi and ejected through divergent nozzles against the rock surface. This action causes a thin layer to break away or spall from the mass and upon rotation of the burner exposes new surface to the flame as the broken spallings are continuously ejected from the hole by steam produced when the cooling water comes in contact with the heat of combustion. Gaseous O_2 at 150 psi is supplied to the machine by pipeline and hoses from a liquid oxygen converter unit located near the mine site. Fuel oil is brought to the machine by tank truck and water is piped in by gravity from a nearby lake. Process fluid consumptions are 10,500 cu ft of O_2, 40 gal of fuel oil and 1,200 gal of water per hr. The machine is capable of drilling to a depth of 50 ft. Speeds in excess of 35 ft per hr have been attained but, the average rate is about 18 to 20 ft per piercing hr. The jet pierced hole is corrugated due to the difference in spallability of the taconite layers, so that a 6½ in. minimum diam hole has an average diameter of about 9 inches. Present practice calls for drilling a 6½ in. minimum diam hole to a depth of 3 ft below pit grade, and chambering or enlarging the bottom 3 ft by making a second pass over that portion of hole. This results in increased volume at the bottom for added explosive where it is needed most.

In order to obtain proper fragmentation of material for the crusher, a coordinated program of drilling and blasting is essential. Primary blasting is carried out with high velocity, high density, insensitive, water resistant explosives. Various delay patterns, explosives distribution and hole spacings have been used with the present single row, individual hole delay on an 18 x 22 ft spacing producing reasonably good fragmentation. Because of the extreme irregularity of the taconite surface, backbreak and hardness, each hole is tailored to fit existing conditions and a complete record is made of each blast. The engineers locate each hole, determine depth of each hole, height of chamber and calculate the available yardage of each hole. From this information is calculated the powder load, distribution and height of stemming required. In general, an attempt is made to load 50 per cent of the powder into the lower one-third of the hole, then continue up the hole with a lighter column to within 8 or 9 ft of the top. The remainder of the hole is then filled with stemming to retain explosive's energy. Natural jointing planes that form large blocks above the powder column would ride out on top of the blast without breaking unless something is done to prevent it. To cope with this situation, a series of small satellite holes 1½ in. in diam and 4 to 6 ft deep are drilled between the large hole, loaded with powder, and fired simultaneously with the parent blast hole. Two detonators in each hole—one near the bottom and one near the top—are each fastened by a double strand of primacord to the trunk line which contains a 17-millisecond delay connector between each hole. The sequence of firing is varied depending upon condition of face and results required. After the blast, any oversize chunks are cast aside and broken with a 6½-ton drop forging or skull cracker mounted on a 2½-yard crawler crane with a 60-ft boom.

Loading of the ore is done with 6½-yard electric shovels equipped with a 5-yard manganese steel dipper, whistler bases and teeth. The hard abrasive qualities of the taconite causes excessive dipper and tooth wear. Considerable experimenting has been done with teeth made of manganese, alloy steels of many compositions and hardness and the application of practically all types of hardfacing electrodes. Where a set of manganese teeth similar to those in most Range operations would require rebuilding and hardfacing after 250 to 350 truck loads, the presently used special alloy steel one-use tooth produces between 650 and 900 loads per set. No welding or hardfacing is necessary on this tooth—just put it on, wear it down and scrap it. Additional savings are realized by decreased shovel down time for tooth changing and considerable reduction of welding force.

Original plans called for rail haulage in the pit after development of the initial cut with 22-ton, end dump trucks. This initial cut is a long narrow cut just wide enough to operate one shovel loading into trucks. After a year of operation with experiments in practically every phase of mining, considerable knowledge in preparing and handling this taconite was gained. Since this material has to be blasted hard and moved forward for good breakage, rail haulage would be impractical in a narrow cut of this nature so it was decided to work toward development of a low cost high capacity rubber-tired trucking unit. Several of the major earth moving companies, with our recommendations, designed and built tractor-trailer side dump experimental units. A series of tests were conducted and studies made to determine practicability and operating costs as applied to this particular operation. The unit decided upon is a tractor-trailer side dump unit powered by a 300-hp engine and capable of carrying an average load of 45 long tons. The trailer and liners are made of high strength alloy steel plate. Experience with present trucks has shown that mild steel truck boxes even though lined with manganese or alloy steel bars will not hold up under impact of shovel loading this hard, sharp-cornered, abrasive material.

By using a tractor-trailer unit on well-maintained roads and minimum pit grades, it is possible to increase the payload to 100,000 lb with the same horsepower now used to haul 45,000 lb with an end dump unit. Road maintenance is of utmost importance to truck haulage; especially, where spillage results in excessive tire cutting. Fine crushings are brought back to the

pit and spread along the pit bottom at shovel loading points. A bulldozer is stationed at the shovel all of the time to push rock spillage from loading area, and a patrol is used for road maintenance between pit and crusher.

The side dump trucks will be dumped at the crusher by a stationary overhead dumping arrangement which will hook on to the side and raise and lower the box by pushbutton control.

The crusher will be a 60-in. gyratory equipped with two 500-hp motors and will crush pit run material to 9-in. size and discharge into three 30-in. crushers each equipped with a 300-hp motor that will crush to 4 in. The 4-in. material is then fed by an 84-in. pan feeder onto a 60-in. belt conveyor and conveyed to two 5,000-ton storage bins. Here it is loaded into 90-ton flat bottom railroad cars and transported 48 miles to Silver Bay.

At Silver Bay the ore will be dumped, two cars at a time, by a rotary dumper into a large pocket and then fed by pan feeder onto a 60-in. conveyor belt which delivers it to four 4,800-ton concrete surge bins ahead of the fine crushing plant.

The fine crushing plant consists of four units—each unit is made up of two 6 ft x 12 ft double deck screens and two 7 ft shorthead cone crushers together with necessary chutes and conveyors. The flow of the ore through one unit is by gravity and as follows:

From the 4,800-ton storage bins, the ore is delivered by pan feeder and belt conveyor to a 6 ft x 12 ft, two-surface vibrating screen with a ½-in. opening on the bottom deck. The material that passes through the bottom deck is dropped directly to a collector conveyor and conveyed to the concentrator storage bin ahead of the rod mills. The overs from the screens is discharged into a 7-ft shorthead cone crusher equipped with a coarse bowl set at an opening of approximately 1 in. The discharge from this crusher then flows over a second 6 ft x 12 ft two-surface vibrating screen taking out the ½ in. material which again goes directly to the concentrating bins. The overs from the screen drops into a second 7-ft shorthead crusher which is equipped with a fine bowl set at approximately ¼-in. mesh. The discharge of this crusher which contains not more than 5 per cent of ¾-in. material joins the ½-in. material from the screens and is conveyed to concentrate bins. There are 24 of these bins and they have a capacity of 3,000 tons each.

The concentrating plant at Silver Bay consists of 12 individual sections each with a capacity of 1,000 tons of concentrates per 24-hr day. These sections are absolutely independent of one another and can be operated separately or collectively. Each section consists of two storage bins, one rod mill, two double drum magnetic cobbers, two ball mills, eight 12-in. cyclone classifiers, eight magnetic belt rougher separators, six double-drum finishing magnetic separators, four hydroseparators, one disc filter and other accessory equipment. All of the material flows through the mill by gravity with the exception of the ball mill rougher classifier circuit which requires the use of one 8-in. pump.

From the storage bins the ore is fed by Mexican feeders on to vari-speed conveyors through four openings in the bottom of each bin. These vari-speed conveyors deliver the ore to the rod mill. The rod mills, each 10½ ft x 16 ft, are powered by 800-hp synchronous speed motors and can handle 125 to 135 tons of ore per hour, producing a product containing not more than 10 per cent + 10 mesh. The rod mill discharges through an attached trommel screen that splits the feed equally to the two magnetic cobbers. The cobbers are double-drum concurrent type covered with an endless belt. Here 35 per cent of the initial feed is thrown out as a low grade tailing. The concentrate discharged from the cobbers flows to the ball mills for further grinding. The two ball mills are 10½ ft x 14 ft and are powered by 800-hp synchronous speed motors. The discharge of the ball mills is treated by eight belt-type magnetic separators and the concentrates pumped into eight cyclones for classification. With the tailings going to waste, the system is set to grind to 80 to 85 per cent —325 mesh.

The —325 mesh produced in the cyclones is further treated in a 16 ft diam hydroseparator to wash out more of the fine tailings. Underflow is fed to six magnetic finishing separators. These separators are of the double drum counterflow design. The tailings go to waste and the concentrate is discharged into two more 16-ft diam hydroseparators for further cleaning. The underflow from the hydroseparators is pumped by diaphragm pumps to a six-disc 6-ft diam leaf type filter where the fine concentrate is dewatered to approximately 10 per cent.

The final product, somewhere between 80 to 85 per cent —325 mesh, averages 64.5 per cent total iron. From here, it is delivered to surge bins for further processing in the pelletizing plant.

DISCUSSION

PRESENTED BY

WILLIAM SCHARFENAKER, Masonry Superintendent, Steel Div., Ford Motor Co., Dearborn, Mich.

ROBERT J. LINNEY, Manager of Operations, Reserve Mining Co., E. W. Davis Works, Silver Bay, Minn.

IRVING ROZIAN, Supervisor of Product and Facility Planning, Steel Div., Ford Motor Co., Dearborn, Mich.

DON SHATTUCK, Superintendent Coke Plant, Blast Furnace Div., Great Lakes Steel Corp., Ecorse, Detroit, Mich.

H. F. LESSO, Metallurgist, Open Hearth Control, Great Lakes Steel Corp., Ecorse, Detroit, Mich.

W. F. STOWASSER, Allis-Chalmers Manufacturing Co., Milwaukee, Wis.

William Scharfenaker: The material which has been used so far in blast furnaces, how does it go down through the stack? Does it indicate some possible future change in the batter of the furnace or its shape? Do the present furnaces take it all right?

Robert J. Linney: We are charging these pellets into the blast furnace, and so far there is no indication that there is going to have to be any change in the lines.

Irving Rozian: What is the density of the three products—nodules, pellets, and sinter—as compared to ore?

Robert J. Linney: From tests that were made at the Bureau of Mines' Experimental Station, the nodules are supposed to be more dense than the pellets, and the pellets are supposed to have more microscopic porosity than even sinter. In comparing the nodules with pellets, reducibility tests were made at the Mines Experimental Station on nodules, on pellets and on Adirondack sinters. The report that I received is that there is very little difference in the reducibility of the nodules and the pellets, and both of them have greater reducibility than any of the Adirondack sinters.

Don Shattuck: What is the cubic foot weight of pellets?

Robert J. Linney: A pellet is about 115 lb per cu ft. It all depends on the size of pellet. The pellet we are producing runs between 110 to 115 lb, where, I think, raw concentrates run around 150 to 160 lb.

H. F. Lesso: Relative to the stability index value of 90.0 per cent quoted, would such stability value still be relatively maintained after substantial periods of storage in open areas exposed to the weather?

Robert J. Linney: There is very little breakage of the pellets stored out in the atmosphere. There was from the physical handling of putting them in storage and taking them out. The blast furnace people we are dealing with use minus 28 mesh as a measuring stick. We are shipping pellets into Chicago in the Republic plant and into Hamilton, Ohio, the Armco plant, and we have had screen tests made on the pellets delivered. In Chicago the —28 mesh has run as low as 3.8 per cent, after ship loading, railroad handling, and as low as 5½ per cent after additional railroad handling on the lower lake points. So it indicates the pellets are standing up very well under delivery.

H. F. Lesso: Have there been any differences found in the stability index with variable residual lime values?

Robert J. Linney: We do not add lime in our pelletizing. We add bentonite in the green ball.

W. F. Stowasser: We had pellets stored together outdoors for two years, and those pellets have no obvious disintegration after that period.

Robert J. Linney: Actually, a pellet is very porous and, laying out in a stockpile, will pick up as high as five per cent moisture. You can take a mouthful of smoke and blow smoke through it. While you cannot see through it, you can blow smoke through a pellet.

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PROGRAM

AISE SPRING CONFERENCE

AUSPICES OF ROLLING MILL COMMITTEE

LORD BALTIMORE HOTEL **BALTIMORE, MD.**

APRIL 30, MAY 1, 2, 1956

MONDAY, APRIL 30, 1956

8:30 am — Registration — Second Floor Foyer, Lord Baltimore Hotel

9:00 am — Rolling Mill Session — Calvert Room

Chairmen: C. S. Lambert, Superintendent Merchant Mill, Campbell Works, Youngstown Sheet & Tube Co., Youngstown, Ohio.

R. P. Schuler, Superintendent, Cold Strip Department, Inland Steel Co., Indiana Harbor Works, East Chicago, Ind.

"The New 10-in. Bar Mill, Jones & Laughlin Steel Corp.," by H. I. Smith, Assistant Superintendent Rolling Mills, Jones & Laughlin Steel Corp., Pittsburgh, Pa.

"The Johnstown Rod Mill of Bethlehem Steel Corp.," by J. C. Seibert, Superintendent, Rod and Wire Dept., Bethlehem Steel Corp., Johnstown, Pa.

"New Flexible High Speed Bar Mill at Phoenix," by Hugh H. Campbell, Manager of Manufacturing, Steel Div., Phoenix Manufacturing Co., Joliet, Ill.

9:00 am — Electrical Session — Caswell Room

Chairmen: D. C. McCrady, Superintendent Electrical Department, Steel Co. of Canada, Ltd., Hamilton, Ontario, Canada.

R. T. Winterringer, Assistant Superintendent, Electrical Department, Republic Steel Corp., Chicago, Ill.

"Product Quality — Keynote of Drive Systems Engineering," by E. H. Browning, Manager, and L. F. Stringer, Steel Mill Engineer, Metal Working Section, Industry Engineering Dept., Westinghouse Electric Corp., East Pittsburgh, Pa.

"Application of Preset Screwdown on Reversing Rougher at Granite City Steel," by A. W. Schlechte, Chief Electrical Engineer, Granite City Steel Co., Granite City, Ill., and C. Allan Schurr, Control System Engineer, The Electric Controller and Manufacturing Co., Cleveland, Ohio.

"Power Requirements and Selection of Electric Equipment for Reversing Cold Strip Mills," by J. E. Peebles, Steel Mill Engineer, Systems Application Engineering Section, General Electric Co., Schenectady, N. Y.

2:00 pm — Rolling Mill Session — Calvert Room

Chairmen: A. M. Cameron, Superintendent Rolling Mill, Atlas Steels, Ltd., Welland, Ontario, Canada.

James N. Imel, Superintendent Sheet and Strip Departments, Jones & Laughlin Steel Corp., Pittsburgh, Pa.

"Sound Steel Without Hot Tops," by George A. Dornin, Jr., Consulting Engineer, Warren, Ohio.

"Wide Flange Beam Rolling at Inland Steel Co.," by W. E. Dittrich, Superintendent, Plant No. 2 Mills, Inland Steel Co., East Chicago, Ill.

"The Forming of Flanged and Dished Heads," by Harry S. Beers, Superintendent Flanging Dept., Wickwire Spencer Steel Div., The Colorado Fuel and Iron Corp., Claymont, Del.

2:00 pm — Mechanical Session — Caswell Room

Chairmen: C. W. Bruce, Chief Engineer, Republic Steel Corp., Chicago, Ill.

H. R. Knust, Assistant to the General Manager, Bethlehem Steel Co., Sparrows Point, Md.

"A New High Strength Oxide Cutting Tool," by Louis M. DeMarco, Sales Engineer, Stupakoff Div., Carborundum Co., Latrobe, Pa.

"Rolling Mill Spindle Maintenance at Gary Steel Works," by Russell H. Davis, Maintenance Metallurgist and I. D. Pottorf, General Supervisor Maintenance Development, United States Steel Corp., Gary, Ind.

"Development of the Multi-Row Cylindrical Roller Bearing Roll Neck Mounting," by E. C. Denne, Jr., Manager, Rolling Mill Div., SKF Industries, Philadelphia, Pa.

TUESDAY, MAY 1, 1956

9:00 am — Rolling Mill Session — Calvert Room

Chairmen: F. C. Kredel, Chairman Bar Mill Committee, Republic Steel Corp., Cleveland, Ohio.

R. C. Schaefer, Superintendent, Hot Strip Mill, Wheeling Steel Corp., Steubenville, Ohio.

"Power Requirements of Rolling Mills," by James H. Taylor, Chief Electrical Engineer, United Engineering and Foundry Co., Pittsburgh, Pa.

"Current Developments in Spindle Couplings," by Wayne Belden, President, Ajax Flexible Coupling Co., Inc., Westfield, N. Y.

"Cause and Prevention of Hot Strip Work Roll Banding," by Charles E. Peterson, Chief Metallurgist, Mackintosh-Hemphill Div., E. W. Bliss Co., Pittsburgh, Pa.

9:00 am — Combustion Session — Founders Room

Chairmen: F. Bruce Bevelheimer, Power and Fuel Engineer, Ford Motor Co., Steel Division — Rouge Plant, Dearborn, Mich.

G. H. Krapf, Division Superintendent — Power Production, United States Steel Corp., South Works, Chicago, Ill.

"Stone Pit Lining Experience at Ford," by William J. Scharfenaker, Masonry Superintendent, Steel Div., Ford Motor Co., Dearborn, Mich.

"Cascade Temperature Control System on a Billet Heating Furnace," by Jack M. Hess, Assistant Fuel Engineer, Johnstown Plant, Bethlehem Steel Co., Johnstown, Pa.

"Advantages of the Five-Zone Furnace in Current Mill Practice," by J. E. Hovis, Sales Engineer, Industrial Furnace Div., The Gas Machinery Co., Cleveland, Ohio.

2:00 pm — Off-the-Record Rolling Mill Panel Discussion — Calvert Room

Moderators: Don C. Horsman, Assistant General Superintendent, Continental Steel Corp., Kokomo, Ind.

Louis Moses, Mill Engineer, Bethlehem Steel Co., Bethlehem, Pa.

The following topics will be covered in this panel discussion (1) breakage of work rolls on hot strip mills; (2) roll cooling; (3) roll crowning; (4) mill guides; (5) cast steel work rolls in hot strip finishing stands; and (6) billet preparation.

Discussion by: Dr. Charles F. Peck, Associate Professor, Department of Civil Engineering, Carnegie Institute of Technology, Pittsburgh, Pa.; Howard S. Orr, Project Development Engineer, Rolling Mills, United States Steel Corp., Pittsburgh, Pa.; R. C. Schaefer, Superintendent, Hot Strip Mill, Wheeling Steel Corp., Steubenville, Ohio; Louis Moses, Mill Engineer, Bethlehem Steel Co., Bethlehem, Pa.; Dr. F. H. Allison, Jr., Vice President — Roll Metallurgical Research, Rolls Div., Blaw-Knox Co., Pittsburgh, Pa., and Don C. Horsman, Assistant General Superintendent, Continental Steel Corp., Kokomo, Ind.

7:00 pm — Informal Stag Dinner — Calvert Room

Speaker: Stewart J. Cort, Vice President, Bethlehem Steel Co.

WEDNESDAY, MAY 2, 1956

8:30 am — Inspection Trip

Bethlehem Steel Co., Sparrows Point, Md. Buses will leave from Lord Baltimore Hotel.

HOTEL RESERVATIONS

For hotel reservations, write directly to the Lord Baltimore Hotel giving time of arrival, type of accommodations desired and period of stay. Reservations should also state that they are for the 1956 AISE Spring Conference.

Bethlehem's Sparrows Point Plant will be site of inspection trip.

EXTRUSION OF METALS

By
G. A. MOUDRY
Chief Metallurgist
Harvey Machine Co., Inc.
Torrance, Calif.

Contrary to what might be expected, steel can be extruded at speeds much higher than aluminum and also does not require as high pressures as aluminum . . . on the other hand, the extrusion temperature of steel is much higher, about 2300 F, with far worse effects on the die blocks.

▲ TWO requirements must be met in the working of metals: Necessary metallurgical properties and the desired configuration for the application.

Other factors, including cost, may determine the choice of the metal-working process to be used in arriving at a desired component. However, properties and dimensions remain the paramount requirement.

There is an old belief that the longer and harder one works a metal, the stronger and tougher it will become. Through the years of forging and rolling operations, this has been accepted as a natural truth; and even today an argument can be waged advancing this old metal-workers' tale. The extrusion process has emerged as a refutation of this belief. It is unique in its simplicity and working effectiveness. There is no other known process that works metal more thoroughly in one operation than that of extrusion. A billet of cast structure fresh from a melting operation can be transformed into a wrought shape of uniform and complex cross-section to the length desired in one press cycle.

Basically, the process consists of locking a die with a desired shape orifice at one end of a closed cylindrical container, placing a heated billet in the container, and, by means of a ram, forcing the billet through the die orifice. The plastically flowing metal assumes the configuration of the die orifice through which it is forced. The energy supplied by the ram is transmitted through the billet to cause flow of metal through the die, although energy is lost through heat dissipation and the overcoming of friction.

Historically, the extrusion of metals among metal-working operations is comparatively new. Aluminum alloys have used the process for less than forty years, and most of the activity has centered about this light metal. Copper and its alloys, lead, and magnesium alloys use the extrusion process, but in a minor role in comparison to that of aluminum. At the present time, there are over two hundred extrusion presses above five hundred-ton capacity producing aluminum alloy shapes, rod, bar, and tubing.

The growing extrusion industry results from the fact that extruded sections provide the highest possible degree of structural efficiency and the greatest possible versatility in design configuration. Placement of the proper amount of material at the right place can more easily be achieved by extrusion than by any other of the common fabricating methods. The elimination of forging draft, machine cutter radius allowances, metal bend radii limitations, and excess material to provide for attachment by welding or mechanical fasteners, has been taken advantage of by the structural and design people in the metal-fabricating field. This has led to an ever-expanding extrusion industry, and new innovations in the industry have led to another expanding field for extrusion.

As recently as twenty years ago, the aluminum industry confined its operations for extrusion to but a few small presses used for the production of small angles, tees, and zees for the aircraft industry, and minor trim moldings for automobiles and architectural operations. Not until World War II did the extrusion press come into its own. The aircraft engineer, at that time, found that the angles and tees could be joined together and that complex configurations could be made out of a variety of parts which at one time were riveted together from "spaghetti" components. Larger presses made larger sections available, and large sections of airplanes soon were being produced on a mass production basis for the aircraft industry.

Following World War II, when aluminum became a by-word in architectural and structural applications, it was discovered that the aluminum extrusion could very well become a major outlet for aluminum. This has been proven, and today, the extrusion press stands as a foremost metal-worker in the aluminum industry.

Taking advantage of the versatility of the extrusion process, the aircraft design engineers have been requesting larger extrusion presses, so that extruded sections of greater cross-section configuration can be pro-

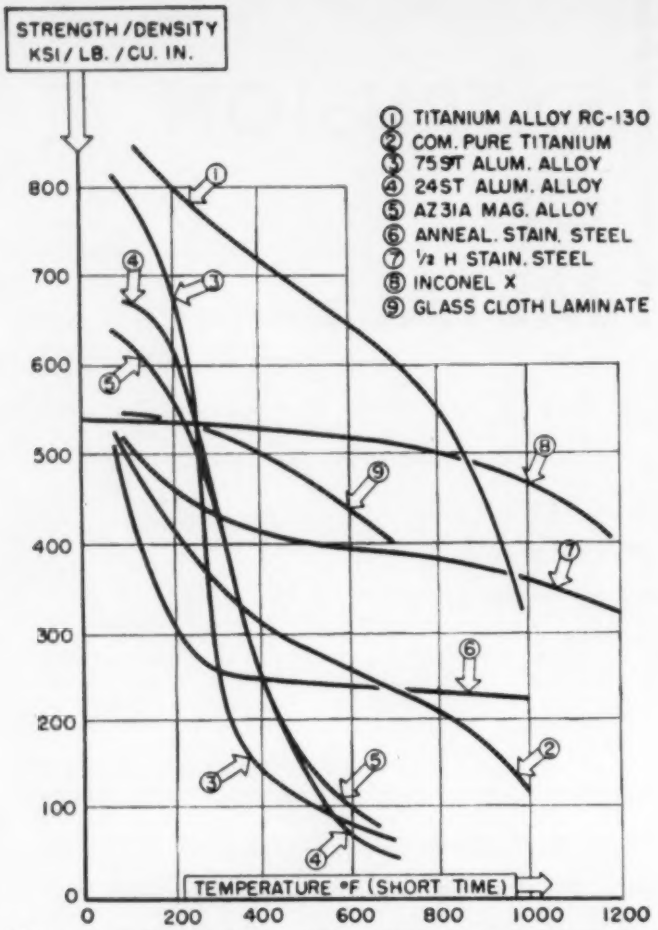


Figure 1 — Chart gives specific strength vs temperature for several materials.

duced. This has resulted in the heavy press program which calls for the installation of extrusion presses up to 12,000 tons in capacity. This compares with the five hundred-ton peanut press of twenty years ago. New presses ranging from 8,000 to 12,000 tons being installed under the Air Force Heavy Press Program will be able to produce sections or panels, that at one time were manufactured from sheet, plate, extruded stringers, and innumerable rivets. With these presses, integrally stiffened panels, wherein the entire structure will be extruded in one section, will provide a much stronger component at a lower price and a smaller amount of human effort.

This, then, is the history of the evolution of the extrusion process in the aluminum industry. The basic process has not changed. We still take a sound cast aluminum billet at a temperature of approximately 750 F, and by means of hydraulic force, exerted by a ram, force this billet in a closed container through the orifice of a die placed at the opposite end of the container. However, we have learned a lot in knowledge of the art. Metallurgical factors which provide a sound product, and die design which provides a complicated configuration to the tolerances desired, together with modern extrusion presses which will produce the horsepower to make larger sections possible, have given the extrusion industry aluminum as it is known today.

Just recently, we find the extrusion process branching out to encompass metals that at one time were considered practically impossible for production by the extrusion process. Steel, one of the oldest and by far the most important of the working metals, is now emerging in the extrusion picture. The newcomer metal, titanium, also appears as a potential material for extrusion. These two materials, possibly, are of the most importance from the standpoint of interest in this paper.

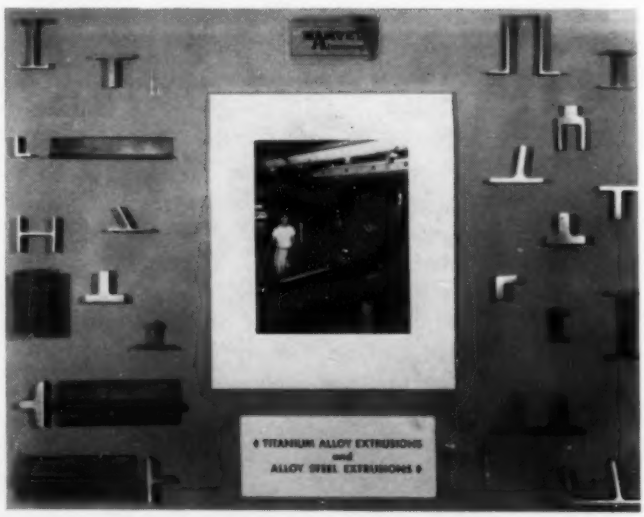
Although the extrusion of steel has been at least a topic for discussion and patents for over fifty years, there has been but little activity until recently. One patent on record, granted in 1896, concerns itself with the details of construction of a press and die for the extruding of steel and other metals. The use of a refractory lubricant is also discussed in the process. Two significant factors are responsible for the advent of steel into the extrusion picture. One, is aircraft with its impetuous engineering search for stronger and better materials in configurations usually impossible to procure and at a saving to the ultimate aircraft. The second is the advent of steels which have been found difficult to roll or fabricate by usual methods. The publicity attending the announcement of the French Ugine Sejournet process for extruding hot steel, contributed significantly toward revival of research and development work on the extrusion of hot steel.

The use of extrusions of steel to provide more efficient structural design, coupled with the ability to produce sufficient and desirable shapes from temperature resistant materials, is a most important tool to meet the problems encountered at elevated temperatures.

The hardness of the materials which we are now considering precludes economic fabrication by the conventional methods of rolling, forging, drawing, or machining. Extruding is not only the last resort, but, indeed, is an economical means of producing to a desired configuration those materials which are virtually impossible to produce by any other means. The problems involved in straightening, forming, heat treating, and processing will be no more difficult for extruded products, but will actually be simplified by the very use of extruded sections in steel.

The extrusion process permits fabrication of shapes too complex to be rolled, permits production of rela-

Figure 2 — Typical titanium and steel alloy extrusions are shown.



tively small lots of special shapes due to low cost of extrusion dies, and permits fabrication of alloys which cannot be successfully rolled. Today, complicated steel shapes currently used in aircraft to a limited extent are produced by machining from bar stock and forgings. The potential saving of time and labor, if such shapes can be produced by extrusion, is enormous. Furthermore, machining of such shapes from bar stock reduces most of the metal to chips. The necessity for conserving metals during critical periods hardly needs emphasizing at this time.

Steel is one of the easiest metals to work, except for the temperature. Its flow characteristics in its plastic range are far superior to aluminum. However, with working temperatures up to 2,300 F, and with pressures over 100,000 psi, there are few materials within reach of the metallurgist to withstand the extrusion operation.

A considerable amount of industrial and production know-how has been accumulated in the aluminum extrusion industry. The information and experience at our plant was applied to the problem of hot extruding steel and titanium shapes. This includes effective use of extrusion presses and furnaces, as well as proper utilization of facilities for tooling design and fabrication. Using the basic extrusion process, alloy steel is extruded at temperatures of approximately 2,300 F into configurations hitherto deemed impossible to procure except through expensive rolling operations, together with machining fabrication.

The rate of extrusion is remarkable when compared with that of aluminum. One of the strongest aluminum alloys, 7075 extrudes at an average speed of approximately 5 fpm. Steel alloy 4340 is extruded at a speed approaching 1,000 fpm. The aluminum alloy does not plastically flow properly if speeds are increased, but breaks up because of frictional forces in the ingot and at the die surfaces. Steel does not have this tendency. As stated before, the metal has ideal extrusion qualities if it were not for the temperature.

In the extrusion of aluminum alloys, lubrication is to be abhorred. Lubricating oils and greases tend to form blisters on the surfaces of the ultimate aluminum extrusions, as well as internal laminations which lead to rejection. Every precaution is made to assure clean tools and billet-free from any oily substances. With steel, the opposite is true. It is almost impossible to provide too much lubrication. In fact, lubrication is so important that refractory-type materials, such as glass, often are utilized to make certain that a lubrication film is present between the steel billet and the extrusion tools.

The billet used for steel extrusion can be of cast structure, as well as wrought. Both, as in aluminum, are satisfactory, and the only cause for partiality lies in the availability and the cost.

Heating of the billet is best accomplished in a salt bath or induction heating furnace. However, gas or oil-fired convection and direct-fired equipment can be used. With these, precautions must be taken to prevent decarburization and scale formation.

Speed in all operations is a requisite in the successful extrusion of steel. The time at temperature above the

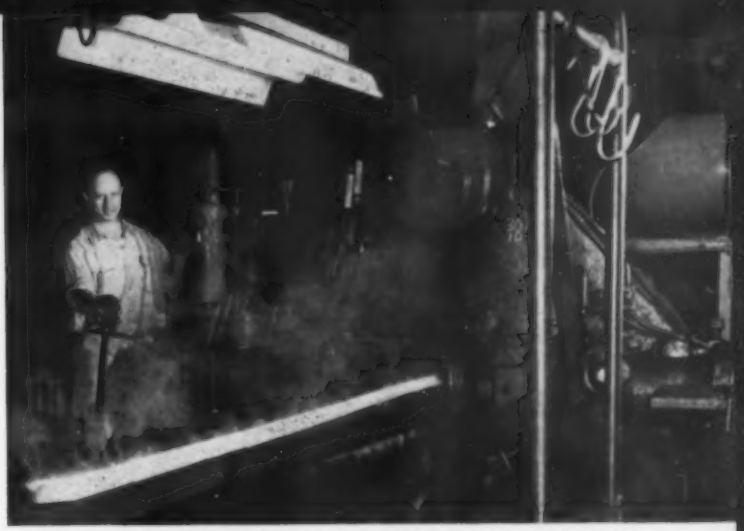


Figure 3 — Titanium alloy tee shape is emerging from extrusion press.

scaling point and the interval between the furnace and the extrusion container, should be as short as possible to minimize scaling. Scaling acts as an abrasive on the extrusion tooling. Speed is important to force the hot steel billet out of the press container and through the die as rapidly as possible. Any pause will result in overheating of tools with accompanying tool failure. Aluminum extrusion cycles vary from one minute to as long as thirty minutes. Steel is extruded in a matter of seconds. This illustrates the excellent flow characteristics of the metal.

Speed is also needed following the extrusion operation in severing the butt or discard from the extruded section. This is necessary in order to remove the section from the die. With aluminum, this can be a leisurely operation; but with steel, speed is all important again to prevent overheating of the die bearing.

The extrusion pressures used for steel are moderate and definitely below those used for aluminum alloys. At the temperature used, the hydraulic pressures are usually below 3000 psi down to 2000 psi with approximately 4000 psi available. This, again, is one of the paradoxes of metal-working, in that aluminum alloys, considered soft, require greater force to work in their plastic range than do alloys of titanium and steel.

In many respects, the extrusion of titanium alloys provides the same difficulties and necessitates fairly similar practices as with the extrusion of steel alloys. The major difference is the extrusion temperature which is much lower for titanium alloys and usually in the range of 1450 F to 1750 F. Some of the newer alloys on the horizon having excellent mechanical properties at elevated temperatures, may require higher extrusion temperatures. Another difference is the tendency of titanium to gall and seize when passing through the die orifice.

The major difficulties with both steel and titanium are with lubrication and tooling. These assume much greater significance than is the case with non-ferrous extrusion practice. With these two metals, the lubricant is expected to insulate and protect tooling surfaces from high billet temperatures, as well as to reduce friction and thereby lower extruding pressures.

There are a variety of lubricants for the reduction of friction which are fairly satisfactory with these metals, particularly when molten salt from the heating furnace is left on the billet to be extruded. However,

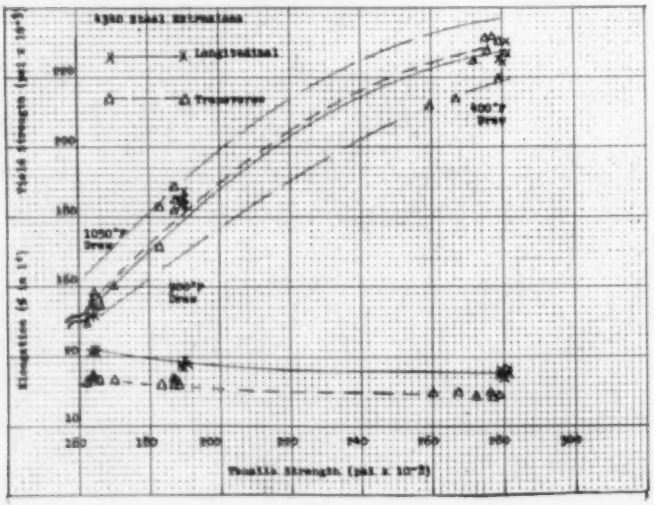
Figure 4 — Alloy 4340 and 4130 steel shapes are shown immediately following extrusion, prior to straightening and clean-up.

it is much more difficult to accomplish suitable die protection at the same time. It is the latter requirement that makes satisfactory solution of the lubrication problem, in connection with steel extrusion elusive. Special-purpose lubricants, such as graphite, petroleum base, moly-disulfide base, metallic coatings, and molten salts are used as a lubricant in the extrusion of these metals.

A different type of lubricant peculiar to hot fabrication are the solid refractory lubricating materials. These soften at the working temperature range of the material being formed. That portion of the lubricant next to the relatively cool die or tooling surface remains solid and, thereby, prevents direct contact between tool surface and hot-worked piece. The portion of the lubricant adjacent to the work piece becomes liquid and flows with the metal being formed, thereby protecting the die orifice.

Another problem is maintaining the straightness of the section during the extrusion process. For aluminum alloys, it is common practice to manually guide the

Figure 5 — Mechanical properties are good in both longitudinal and transverse directions. Curves show data from three heat treatments.



forward motion of the extrusions as they progress along the run-out table from the die assembly. With the relatively slow run-out speeds used, this presents no problem. With heavy sections, corrective guidance is given at the start of the extrusion. However, in the case of steel and titanium alloys, extrusion with the excessive run-out speeds used, it is impossible for anyone to manually guide the material down the run-out table. It is expedient for all present to stand cautiously aside and let the extruding section take its own course.

Straightening after heat treatment again involves somewhat more complex problems than does straightening of heat-treatable aluminum alloys. Lengthy aluminum alloy extrusions become badly distorted during the solution heat treatment operation, and are stretch-straightened immediately following quenching from an elevated temperature. In this "T4" or "W" condition, the aluminum alloy is still soft and easily stretched. It hardens by natural aging in the case of some alloys, or is hardened by artificial aging (precipitation heat treatment) in the case of others. However, with present alloys of steel, no such soft transition stage exists since quenching of steel produces an immediately hard material, martensite, which must then be tempered to restore useful ductility and softness. This is a cue for the steel industry and the research metallurgist to find a precipitation hardening alloy of steel that can be formed in the ductile solution heat-treated condition and subsequently age-hardened to the desired strength level. Present practice is to normalize steel alloy extrusions following the extrusion operation and then straighten in this softened condition.

An important metallurgical characteristic of the extrusion process is the relatively hydrostatic stress state which exists. This results in high density metal, with good continuity of flow lines, and very little tendency for sponginess. In terms of mechanical properties, this means good elongation, high reduction of area, and good notch impact strength in transverse directions.

Tests conducted on production 4340 steel extrusions have shown that the longitudinal tensile strength-ductility relationship is consistently superior to that normally expected from forged or rolled material. However, the most important advantage is in the transverse direction. Here, the strength-ductility relationship is far better than that shown in the data available in the literature on forged and rolled steel, with the major advantage being at the high strength level.

The characteristic extrusion effect encountered in aluminum alloys and resulting in enhanced tensile and yield strengths in the extrusion direction would not be expected, and is not observed in the extruded steel sections. This is logical since such an extrusion effect is a result of preferred orientation, and any preferred orientation of the austenite would be lost as the steel extrusion cools through the transformation temperature. Consequently, the ultimate and yield strengths would be nearly independent of specimen orientation. With these considerations in mind, we could conclude that the quality of extruded sections would be approximately equivalent or superior to rolled sections. The possible differences might be slightly better transverse

ductility and toughness in the extruded section, but slightly more grain size variation.

Because of the temperature used during the working operation, even though mechanical properties appear to be satisfactory, the metallurgical structure is such that it is our opinion that the material should not be placed in service in the as-extruded condition. However, following heat treatment at proper temperatures, the mechanical properties are excellent and as expected.

Practically all commonly-known alloys of steel can be extruded successfully. Some give more trouble than others. Alloys such as 8630, 4130, 4340, and the stainless alloys, such as 410 and 431 are being extruded without fanfare into shapes for subsequent use. As more experience is gained in the extrusion of the more highly-alloyed steels, it can be expected that complex configurations with reasonably good surfaces will be produced satisfactorily.

The metal, titanium, and its alloys, offers particular problems peculiar to the metal alone and different than those offered in other extrudable materials. Its tendency to pick-up, or alloy, with known materials has made it more difficult to work at elevated temperatures.

There is one definite advantage in the extrusion of titanium, and that is *time*. Its affinity for oxygen, nitrogen, and hydrogen at elevated temperatures make time a very important factor. In extrusion, we do not require preliminary breakdown operations, and multiple exposure of material at temperatures and in atmospheres that are conducive to the accumulation of interstitials. Heating to temperature in inert atmosphere furnaces prevents any change in quality of the ingot up to the time it reaches the extrusion press container.

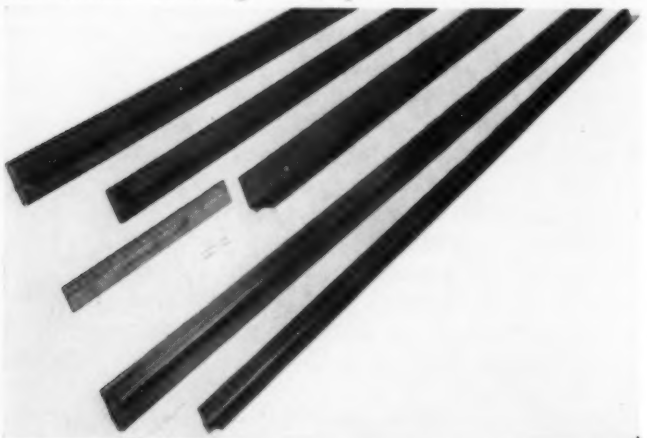


Figure 6 — Titanium alloy produces clean extruded shapes.

Figure 7 — A 12-ft titanium alloy extruded angle is compared with the ingot from which it was extruded.

Figure 8 — Aluminum alloy extruded shapes have been produced for some time.

Working of the metal is conducted in a closed container out of contact with contaminating atmosphere. The cycle is completed in a matter of seconds, and the emerging titanium extruded section is produced with no pick-up of contaminants and practically the identical interstitial composition as the original cast billet. Because of this, one of the exasperating variables in titanium is removed—that of the unpredictability during fabrication of the pick-up of interstitials and the resultant variations in metallurgical properties.

Another advantage in extrusion is the freedom of surface from rolled-in scale and slivers. The surface of the billet, both for steel and titanium, is contained in the butt and does not enter the die orifice. Plastic flow occurs within the billet, and the design of the die effectively blocks off entry of material adjacent to the wall.

Most of the common and exploratory alloys of titanium have been extruded successfully. The higher-alloyed materials usually provide more difficulty, not only at the press itself, but particularly in forming and straightening operations. With steel, it is possible to normalize the material and place it in a condition whereby it is sufficiently soft to straighten in long lengths. Some of the newer titanium alloys, having a hardness at room temperature of a Rockwell C from 35 to 42, have resisted streightening in the cold or room temperature conditions. Elevated temperatures have sometimes been necessary to place these extruded shapes in a salable condition.

With the advent of higher-grade sponge material and more predictable alloys, it has been found that extruded sections can be straightened and formed satisfactorily at room temperature. This will have a far-reaching effect, not only upon the extrusion of titanium alloys, but also upon the successful application in aircraft where forming at room temperature is a requisite.

It has been our intention to summarize the evolution of a complete industry, that of the extrusion of metals, in this one presentation. If there is one paramount point in this treatise on extrusion, it may be in relation to the opening statement. Two requirements must be met in the working of metals—necessary metallurgical properties, and the desired configuration for the application. This is accomplished in the extrusion of metals.

Electrical Equipment for Auxiliary Drives of hot strip mills Part III

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. . . . this is the concluding part of a three-part article in successive issues of the Iron and Steel Engineer . . . . with the heavy investment required by a continuous mill, careful selection of the equipment for the auxiliaries is necessary for the economical operation of such mills . . . .

FLYING SHEARS

▲ MANY mills have a hot flying shear directly after the finishing train for cutting the strip into lengths ranging usually from 16 to 32 ft and to crop front or tail end, or both.

Performance demands on a flying shear drive are severe. It must start and stop quickly to avoid making false cuts; and, when cutting to length at mill speeds near 2000 fpm, the utmost in tight synchronism of shear speed with that of the mill is required to maintain cutting accuracy.

Most existing shears are gear-driven by two shunt wound mill type motors nominally rated 230 volts, but operating at voltages as high as 600 volts. Nominal horsepower ratings are from 100 to 250. Two such 150-hp motors operating at 600 volts effectively have a combined rating of approximately 750 hp. They might be supplied by two 300-kw, 600-v generators with suitable peak load capacity.

Recently there have been at least two shears installed in which the bottom shear drum is direct-driven by a single slow speed (300-rpm) 600-volt, 900-hp, compensated, shunt-wound mill type motor with 300 per cent frequently repeated momentary load capacity. By using such a slow speed motor, direct-coupled to the bottom shear drum (diam 42-in.) the total WK^2 is substantially lower than that with the mill type, higher speed motors. This reduction in WK^2 is of the order of 30 per cent; and it contributes toward faster acceleration and deceleration.

The actual cutting is done by rotational stored energy. Each cut will result in a dip in motor speed; and the greater this dip, the higher will be the motor currents to bring the speed back up to where it belongs. When shearing at mill speeds above 1000 fpm, these dips in motor speed are only a few per cent; and, the resulting motor currents to recover speed are relatively small by comparison with those required to start and stop the shear. Since less than one sec is allowed for full acceleration or deceleration of the shear, the associated currents are always high and any reduction in WK^2 is most welcome.

For low speed shearing, say 750 fpm or lower, reduction in WK^2 may do more harm than good. Since kinetic energy varies as the square of the shear speed, the stored energy at 750 fpm, for example, is only 25 per cent of its 1500 fpm value. Momentary drops in shear speed when cutting heavy material at low speed may be large enough to impair cutting accuracy; and, cutting currents can also conceivably approach dangerous levels with excessive dips in speed. These are the reasons why, in a flying hot shear, there is some optimum value of WK^2 for a specific duty. Some compromise of the theoretical best is of course necessary here, even as it is necessary in most other shear drives be they billet shears, slab shears or what not.

Few, if any, shears operate above 1600 fpm because light gage sheets tend to "take off" and fly out on to the runout table at high speeds as they are kicked forward by the knives. This condition naturally is worse when cutting short lengths because the knives may be moving at about twice strip speed. On a recently installed shear the performance data were specified on a 1600 fpm basis, as follows:

Shear data:

1. One bottom shear head — 42-in. diam — one knife.
2. Two top shear heads (interchangeable):
   a. One 28-in. diam, one knife.
   b. One 31½-in. diam, one knife.
3. Bottom shear head direct-coupled to 900-hp, 300-rpm drive motor.
4. Top shear head geared to bottom head.
5. With 28-in. diam tophead, approximately 1⅞ revolutions of bottom head allowed for first cut and two revolutions per cut thereafter.
6. With 31½-in. diam top head, approximately 2⅞

revolutions of bottom head are allowed for first cut and three revolutions per cut thereafter.

7. Cut lengths ranging from 16½ ft to 22 ft are contemplated with 28-in. diam top head, with corresponding average motor (bottom drum) speeds of 194 and 145.3 rpm at 1600 strip fpm.
8. Lengths ranging from 18 to 33 ft are to cut with the 31½-in. diam top head, with corresponding average motor speeds of 267 and 145.5 rpm at 1600 strip fpm.

Typical control functions are:

1. Crop front end of strip only.
2. Crop tail end of strip only.
3. Crop both ends of strip.
4. Crop front ends and shear to length.

The main operator's controls located in the finishing mill pulpit included the following:

1. One mode selector switch to select anyone of the above functions.
2. One "Off-On" selector switch.
3. One "Manual-Automatic" selector switch.
4. One jogging switch.
5. One mill stand selector switch to select either of two finishing stand speed pilot generators for the shear speed regulating system.
6. One "Length Of Cut" rheostat dial calibrated in ½-in. increments. This simply determines the ratio of strip speed to shear speed.

For setup and maintenance the following shear control devices were mounted on the operator's desk on the mill floor near the shear:

1. One control switch with lock to take control away from mill pulpit operator and to make jogging switch on this desk operative.
2. One jogging switch.
3. One emergency stop pushbutton.

The heart of a good flying shear control is obviously the speed regulator which accurately keeps shear speed proportional to strip speed. The primary control signal to do this job is taken from a speed pilot generator driven by the last mill stand. Figure 33 shows in simplified schematic form a typical regulating circuit. It will be seen that, in reality, there are two regulating loops: the voltage loop and an overriding (higher gain) speed regulating loop.

The longest lengths are cut when the linear speed of the shear knives exactly equals mill delivery speed. On the above mentioned shear, the longest cut is 33 ft when using the 31½-in. diam top knife head which must make four revolutions for every cut. The total distance travelled by this knife for each cut is:

$$\frac{\pi \times 31.5 \text{ in.}}{12} \times 4 = 33 \text{ ft}$$

Since strip and knife speeds are equal, 33 ft of strip will, for the longest cut, have passed through the shear between cuts. All this assumes no dips in shear speed when cutting; in fact, both strip and shear speeds are considered to be absolutely the same. Dips in shear speed result in the cuts being longer than calculated in this way; but, at high speeds the error is extremely small and easily compensated for by the operator's "know how" in actual practice.

The so-called theoretical length of cut for the above shear can be expressed as:

$$\text{Length of cut in ft} = 33 \times \frac{\text{Mill Delivery FPM}}{\text{Shear FPM}}$$

The "Length of Cut" rheostat is an adjustable potentiometer or so-called voltage divider used to select the desired ratio of mill fpm divided by shear fpm.

Repetitive cutting accuracies of plus or minus a fraction of an inch are common — which, when expressed as a percentage of 25 ft for example, is better than 0.3 per cent.

RUNOUT TABLES — GENERAL

The typical modern hot strip mill has over 200 runout table rolls between the finishing train and the coilers. The table is divided into three or four sections each with its own speed control by armature voltage. All rolls are individually driven by direct-coupled d-c motors. Rolls are generally spaced every 18 in. and there are no aprons between them. Figure 33 is a recent runout table installation with 3-hp motors.

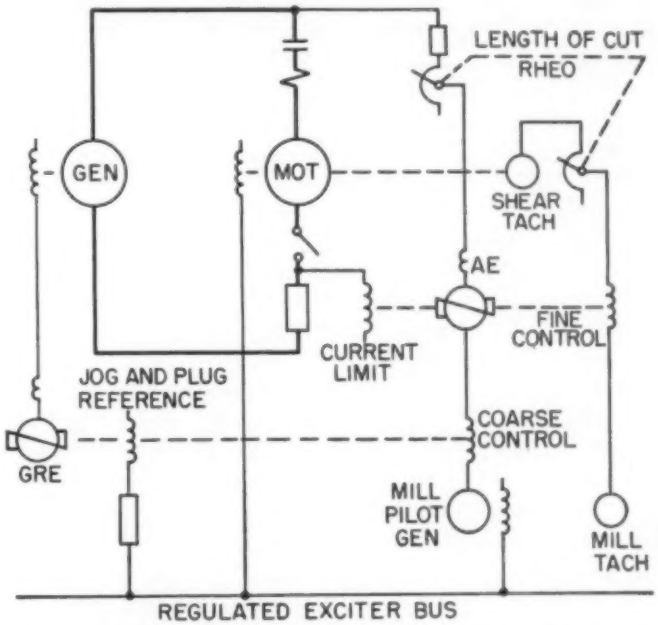


Figure 33 — Simplified schematic (one-line) control diagram for hot strip flying shear.

Prior to 1937, adjustable frequency drives using squirrel cage induction motors were used exclusively on all individual motor-driven table rolls. In that year the d-c runout table motors were introduced by installing them on the tables of Republic Steel Corporation's new 98-in. mill at the Corrigan-McKinney Plant in Cleveland. Some 312, 4.3-hp, 750-rpm d-c motors were installed there to drive 312, 12 in. diam rolls spaced every 24 in.

Shortly thereafter, d-c motors were also installed on the 44-in. mill tables of Inland Steel at East Chicago, and on the 80-in. mill of Carnegie-Illinois at Irvin Works. On both of these installations however, the rolls were gear-driven in pairs. At Inland there are about 360, 12-in. diam rolls with 180, 7.5-hp, 1750-rpm motors; while at Irvin Works there are 400, 12-in. diam rolls driven by 200 motors, also rated 7.5 hp, 1750 rpm. The roll spacing on both of these tables is 18-in. No twin-roll drives have been built since that time. Also, since 1937

there have been no new installations of a-c table motors on typical high speed (approximately 2000 fpm) mills.

The other mills of special interest are the Sparrows Point, 68-in. mill of Bethlehem Steel Corporation, built in 1946, and the more recent 80-in. mill at the Fairless plant of the U. S. Steel Corporation. The Sparrows Point table has the largest number of rolls. There are 445 rolls, 10-in. in diam, driven by 445, 4-hp, 750 rated rpm, d-c motors, spaced 18-in. apart. The table is divided into three sections. The Fairless mill is rated the highest in speed (2335 fpm) of all mills. It has a four-section table with 280, 12-in. diam rolls spaced 18-in. apart and each driven by a 4.4-hp, 825-rpm, d-c motor.

Perhaps the reasons for changing from adjustable frequency a-c motor drives to d-c are not fully understood. Everyone knows that no motor construction is inherently more rugged that that of a squirrel cage induction motor with its case aluminum rotor winding and the complete absence of brushes, commutators and slip rings. The principle of controlling motor speed by controlling its power supply frequency is also well understood. Why then the transition from a-c to d-c? Here briefly are some of the reasons:

1. Power conversion. D-c table motors require one stage of power conversion, namely the motor-generator set to convert from a-c to d-c. The a-c table requires two conversions; first from a-c to d-c and then from d-c to a-c. It is essentially a case of adjustable voltage speed controlling the second motor-generator set by adjusting the generator field on the first set. This double power conversion efficiency is approximately 65 to 70 per cent by comparison with that of the single conversion with its 85 per cent.
2. Slip losses of squirrel cage motors tend to be high, even with "frequency controlled" speed wherein the motors are thrown on the line at approximately one-third of rated frequency and then accelerated by raising the frequency. On wide high speed mills it is not possible to dissipate the losses of the a-c motors.
3. The average accelerating torque is higher in a d-c motor than that in a frequency-controlled a-c motor with the same peak torque rating. Thus the d-c drive is more responsive in that it can start and stop more quickly.
4. More "motor room" space is required to accommodate the additional motor-generator sets and control of the a-c system.
5. Control maintenance is considered to be less with d-c. This compensates, perhaps completely, for the brush and commutator maintenance not required by a-c drives. Incidentally, average brush life of as high as five years has been reported.
6. When taking into account the added cost of power by the a-c drives, many influential engineers in the industry are definitely of the opinion that d-c drives cost less than a-c.

All in all it seems that a-c may be the proper choice for the narrow or slow speed tables involving relatively small amounts of power, and when starting and stopping is not frequent. D-c motors should be used on all large-output mill tables.

Early in Part I of this article it was stated that the special type mill motors were originally designed specially for runout tables; see Figures 34 and 35. Their special features listed there will not be repeated here.

Figure 34 — Flying shear control panel has at extreme right the stand load relay panel controlling operation of loopers and flying shear.

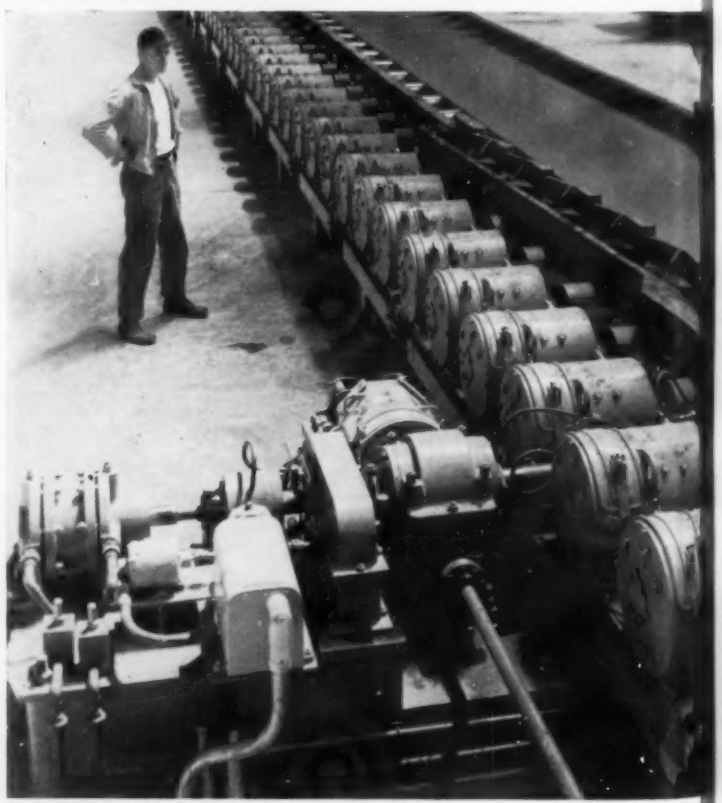


Figure 35 — This recent runout table installation has mill type 3-hp, 250-volt, d-c motors.

SELECTION OF RUNOUT TABLE MOTOR AND GENERAL RATINGS

The major performance requirements of a table drive are that it can accelerate and decelerate quickly, and that it can automatically maintain speed proportional to that of the mill.

Few table motors take more than 30 per cent of rated load when running at constant speed. Even with strip on the table the power is usually less than 50 per cent. Where the starting and stopping is relatively infrequent, there therefore is no motor temperature problem whatsoever; barring no mechanical obstructions such as bent aprons, twisted strip between the rolls, etc. If the table must start and stop with every strip through the mill, a heating calculation check should be made to be sure, otherwise it will be found that in the determination of horsepower ratings of these specially designed 75 degree C rise, Class B insulated motors, *accelerating* torque requirements only determine motor size.

Anywhere from 7 to 10 seconds to accelerate a table section from standstill to top speed seems to satisfy the operators. There are many mills with "slower" tables than this. The inertia of a table roll, even when of hollow construction, is very high. That is why peak accelerating motor torques may approach 500 per cent when starting or when stopping from top speed. Let us consider the following example:

12-in. diam hollow roll (body length 85-in.)	Wk^2	= 200 lb-ft²
Average strip weight per roll . . . . . 40 lb		
Strip Wk^2 per roll	=	10 lb-ft²
Motor Wk^2, approx	=	7 lb-ft²
Coupling Wk^2, approx	=	3 lb-ft²
	Total Wk^2	220 lb-ft²

Top roll speed . . . . . 2300 fpm, 735 rpm
Time allowed for acceleration . . . . . 7 seconds
Average torque required for acceleration of inertia, while neglecting friction, is:

$$\frac{Wk^2 \times rpm}{308 \times sec} = \frac{220 \times 735}{308 \times 7} = 75.0 \text{ lb-ft}$$

Taking a 4-hp, 750-rpm, 250-volt, motor, as a trial selection, with rated torque of 28 lb-ft and allowing approximately 40 per cent, equalling 11 lb-ft for friction, the total mean torque required to accelerate in 7 seconds is:

11 + 75 = 86 lb-ft, or

$$\frac{86}{28} \times 100 = 307 \text{ per cent of rated motor torque}$$

Absolutely constant torque cannot be maintained through the entire acceleration, and peak torques of 425 per cent can be expected for this reason. Although 425 per cent is considerably below the 500 per cent these motors can commutate, it may not be quite low enough to use a 3-hp motor if the 7-sec accelerating time must be met. A relaxing of the 7-sec requirement in favor of 8½ to 9 sec would point to the 3-hp rating with less margin, however, *but* at a substantially lower price, bearing in mind that generator size would also be affected. The 4-hp, however, appears to be the best selection since it combines added torque margin with a shorter accelerating time to make for a "snappy" table by comparison with the average runout table; and quite in keeping with the industry trend toward faster and more responsive drives for maximum production.

Special mill table motors are designed and rated to give any desired top table speed. Inasmuch as 12-in. diam rolls are quite popular as well as table speeds in the vicinity of 2300 to 2500 fpm maximum, basic ratings of 3 and 4 hp, 750-rpm, 250-volts, have been designed. These motors may, on a constant torque basis be operated up to at least 300 volts.

The generator rating for any particular table section must be based upon the sum of all the peak accelerating motor loads. There is negligible load diversity among the 60 or 70 motors of any particular table section. If peak torques in the vicinity of 450 per cent are calculated, the corresponding peaks in armature current will be nearly 20 per cent higher or 540 per cent because motor torque is nearly but *not exactly* proportional to current at these high values.

Economics of design and manufacture usually suggest generators with 300 per cent momentary load capacity to match in amperes the above 540 per cent of rated motor currents. The kw rating is then at least one-third of the required momentary rating. Duplicate generators for all table sections are desirable, and this fact, incidentally, is one of the strongest influences to split the runout table into equal sections.

RUNOUT TABLE CONTROL SECTIONS

Rotating regulator type adjustable voltage controls are used on such tables. Figure 36 shows a rotating regulator type control panel for four table section generators. Featured are:

1. Current limit control to limit current peaks on the generator.
2. Voltage regulation during running, either against a manually preset standard or a speed pilot generator on the mill for speed synchronism with the mill. It is noteworthy that automatic speed matching by means of armature voltage has worked out very satisfactorily, wherever used. Theoretically, at least, it is not as accurate as matching by speed regulators using tachometer type speed pilots on the mill tables would be, but it is plenty good; and, avoids the practical problems associated with the mounting of tachometer generators on the table rolls.

The schematic control diagram is almost the same as already shown in Figure 14, differing only in two respects:

1. "Manual-Automatic" operation is featured in

Figure 36 — Control panel for four runout table section generators.

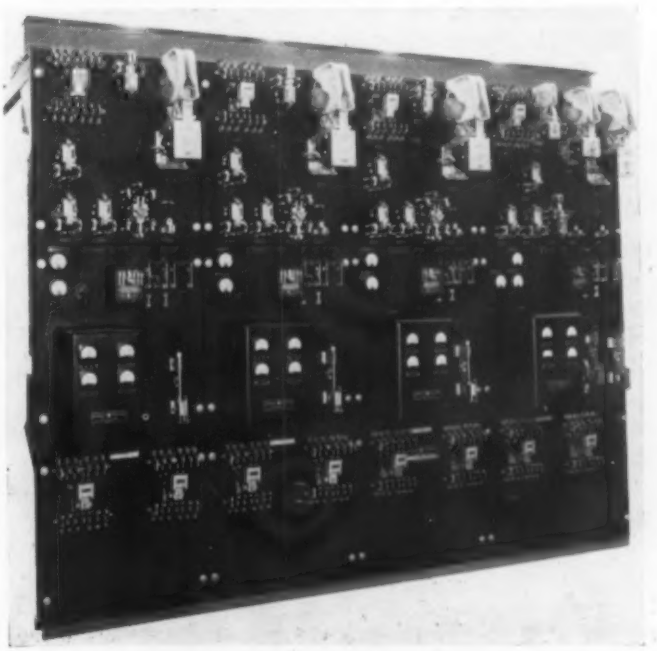


Figure 37 — Individual runout table roll motor protective panels are group-assembled, front connected with two per compartment.

which the "reference" control field is energized by the last finishing mill stand speed pilot generator when on Automatic, thus speed-tieing the tables to the mill by voltage control.

2. The multitude of motors supplied by each generator demand special individual protective panels.

Present day practice is to group assemble these motor protective panels as shown in Figure 37. If all the devices are front-connected the assembly can be mounted against a wall and, in any case, safely away from the table itself. There are many reasons why a table motor needs thermal protection; such as:

1. Bad roll bearings.
2. Warped aprons rubbing on the rolls.
3. Abnormal weight of strip when piled up on the table.

These conditions can be serious enough to stall motors. Sometimes heavy magnets are placed on the table by the crane in attempting to clear it of cobbled strip. In addition the motor itself must be protected against:

1. Loss of field.
2. Armature short circuits.
3. Sometimes, high inrush currents when starting a dead motor "across the line."

Individual protective panels therefore usually provide:

1. Instantaneous overload protection.
2. Thermal overload indication.
3. Loss of field protection and indication.
4. Means for complete electrical disconnection of motor leads.

The schematic diagram of one of the conventional types of protective controls is shown by Figure 38. It includes the minimum amount of protection that can be recommended. Some users request special features which their experiences have indicated will be valuable to them; but perfect protection for all possible conditions is as usual impractical. Actually, the overall operating record of runout table motors is phenomenal — standing as a high tribute to the motor designers. To say that runout table motors must operate under adverse conditions is indeed an understatement. Even with the most elaborate of protective schemes, they are apt to be ignored by maintenance personnel because there simply are too many of them to get individual attention. These forgotten motors perform nevertheless.

RUNOUT TABLE MOTOR MOUNTINGS

There are three basic types of motor mountings:

1. Foot mounting.
2. Flange mounting.
3. Floating mounting.

The motor with four mounting feet is by far the most common. Flange mounting is sometimes used, particularly where foot mounting is difficult such as may be the case with table rolls over the coilers. Floating mountings are promoted strongly by one motor manufacturer, in which the entire motor is completely overhung and carried by one roll bearing. The chief advantage claimed

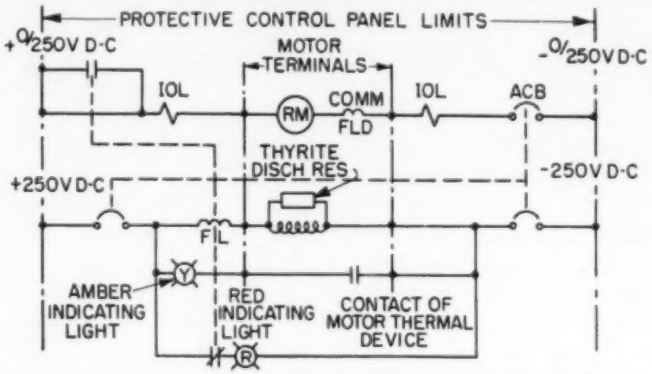


Figure 38 — Schematic diagram shows individual roll motor protective control with field loss protection and indication, instantaneous overload protection and thermal overload protection.

for the floating roll motor is that coupling difficulties are eliminated — such difficulties arising chiefly from warped or bent rolls. With warped rolls the motors simply wobble. Few, if any, floating roll motors are used on high speed tables. A common arrangement these days seems to be that of Figure 39 with a foot motor mounted as part of a single roll-motor assembly with flexible type coupling. The "rubber ball" coupling is used quite extensively, since with extreme roll shaft wobble or misalignment it simply wears out an "fails safe."

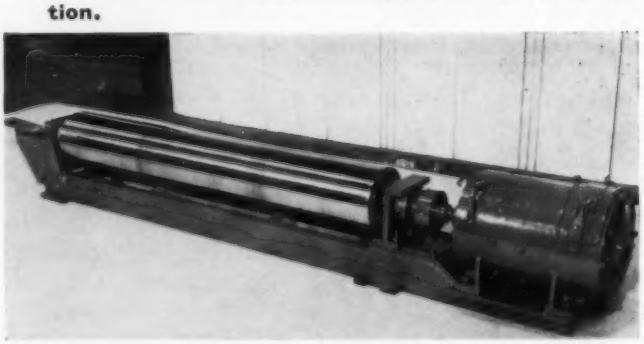
COILERS — GENERAL

The three types of coilers used most extensively in the industry are:

1. Center driven mandrel type downcoiler.
2. Surface driven expanding type downcoiler.
3. Center driven mandrel type upcoiler.

More center driven mandrel type downcoilers have been installed within the past ten years than any other type. This article will therefore be concerned mostly

Figure 39 — Replacement roll and motor assembly for hot strip mill runout table is designed for quick installation.



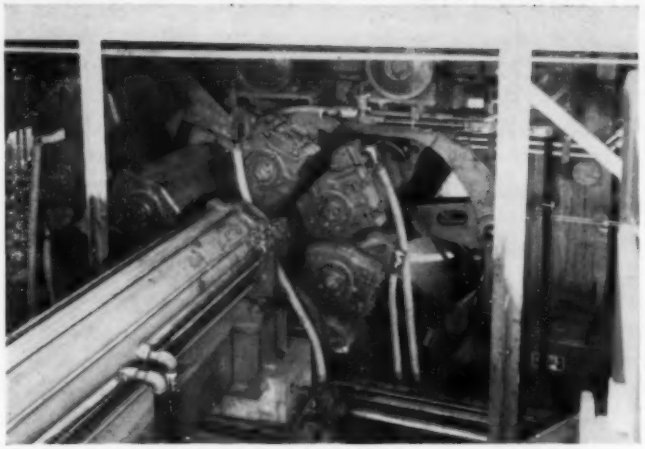


Figure 40 — Surface driven hot strip downcoiler is being outmoded by the mandrel type.

with the electrical equipment for that type of coiler. But before going into details, a few comments on the others are in order.

Prior to the post war era of steel mill expansion, the most popular coiler was the surface driven expanding type. Essentially, it consists of four pairs of motor driven wrapper rolls arranged in a small circle when the coiler is empty, the circle being approximately equal to the inside diameter of the coil. By means of a pair of pinch rolls on the table, a coiler gate, entering throat and suitable guide rolls, the leading end of the strip is directed inside the circle of wrapper rolls, where it is confined and coiled by the wrapper rolls bearing on the outside surface of the coil. The rolls are held there by air pressure and move out as the coil builds up. They are fully retracted for discharge of the coil and then returned to the closed position for the next one. Figure 40 shows such a coiler. This type is now giving way to the mandrel type which is nothing more than the surface driven coiler with motor-driven mandrel added.

The mandrel permits coiling under tension similar to that of a conventional winding reel. The wrapper rolls are still retained to guide the strip around the mandrel and hold it there for the first few wraps until it "grabs" the mandrel. Then, it is customary practice to retract the wrapper rolls to the "open" position until the tail end of the strip comes along when they are brought in to bear on the coil to keep the end from whipping around as the coiler is brought to a stop. Tension is maintained by the mandrel pulling against the mill or table pinch rolls at the coiler or both. When the tail end of the strip leaves the mill, the mandrel will pull against the pinch roll only, plus whatever strip-table friction there happens to be. Motor armature current regulators are provided in the mandrel control to keep field strength proportional to coil diameter and thereby maintain constant tension.

It is generally agreed that mandrel coiling is best. The coils are more compact; the sides are more uniformly straight reducing strip edge damage in handling; and there is less surface scratching. The mandrel type coiler is not limited in the amount of power which may be used for coiling whereas the straight expanding type is definitely limited through lack of surface traction and available space for the motors.

A recent count showed that out of fourteen coilers arranged for center driven mandrel operation, ten were downcoilers and four were upcoilers. The fundamental principle of coiling is the same in both, although they are somewhat different mechanically. One type rolls, sometimes used as wrapper rolls in the upcoiler, have "inside-out" squirrel cage motors built into them, and are operated by adjustable frequency a-c. Whether or not an upcoiler or a downcoiler is selected often depends upon building space considerations, particularly as it concerns the coil conveyor.

Most mills have two coilers to permit coiling on one while the other is unloaded. At least four mills now have three coilers; others are being considered.

Figure 41 shows schematically the center driven mandrel type downcoiler, which will be discussed from here on.

COILER DATA

The following are some coiler and motor data on a few recent installations:

MILL NO. 1

Mill width, in. 56
Mill max fpm. 1925
Pinch rolls — both 16-in. diam, gear-driven by single mill motor, rated 100 hp, 485/1200 rpm, operated at 700 rpm, 230 volts d-c, force-ventilated, continuous 75 C rise.
Wrapper rolls — four pairs of 10-in. diam rolls, each pair gear-driven by special mill type, 25 hp, 700-rpm, 250 volt, d-c motors, totally enclosed, non-ventilated continuous 75 C rise.
Guide rolls—one pair, gear-driven by special mill type, 25-hp, 700-rpm, 250-volt motor, totally enclosed, non-ventilated continuous 75 C rise.
Mandrel, 26-in. diam, gear-driven by mill type motor rated 200-hp, 420/1050 rpm, force-ventilated, continuous 75 c rise.

MILL NO. 2

Mill width, in. 98
Mill max fpm, ... 2120
Top pinch roll, 36-in. diam, driven through 2.25/1 gear by mill type motor rated 75-hp, 515/690-rpm, 230-volts d-c, force-ventilated, continuous 75 C rise.
Bottom pinch roll, 16-in. diam, direct-driven by mill type motor rated 75-hp, 515/690-rpm, 230-volts d-c, force-ventilated, continuous 75 C rise.
Wrapper rolls, four pairs of 12-in. diam rolls, each pair gear driven by mill type motor rated 35-hp, 230-volts d-c, totally enclosed, non-ventilated, 1-hour 75 C rise.
Mandrel, 30-in. diam, gear-driven by mill type motor rated 300-hp, 375/900 rpm, 230 volts, d-c, 75 C rise continuous, force-ventilated.

MILL NO. 3

Mill width, in. 80
Mill max fpm 2335
Pinch rolls — both gear-driven by single mill type motor rated 200-hp, 420-rpm, 230 volts d-c, continuous 75 C rise, force-ventilated.
Wrapper rolls, four pairs, each pair driven by special mill type 25-hp, 700-rpm, 250 volt d-c motors, 75 C rise continuous, totally enclosed non-ventilated.
Guide rolls, one pair driven by special mill type, 25-hp, 700-rpm, 250-volt, d-c motor, 75 C rise continuous, totally enclosed non-ventilated.
Mandrel, gear-driven by mill type motor rated 350-hp, 375/900-rpm, 230-volts, d-c, 75 C rise continuously, force-ventilated.

These examples show how the power to coilers have more than doubled. The horsepowers used on the wrapper rolls are in reality a carryover from those used before the mandrel was introduced; and some of these new coilers can operate, with mandrel removed, as surface drive types.

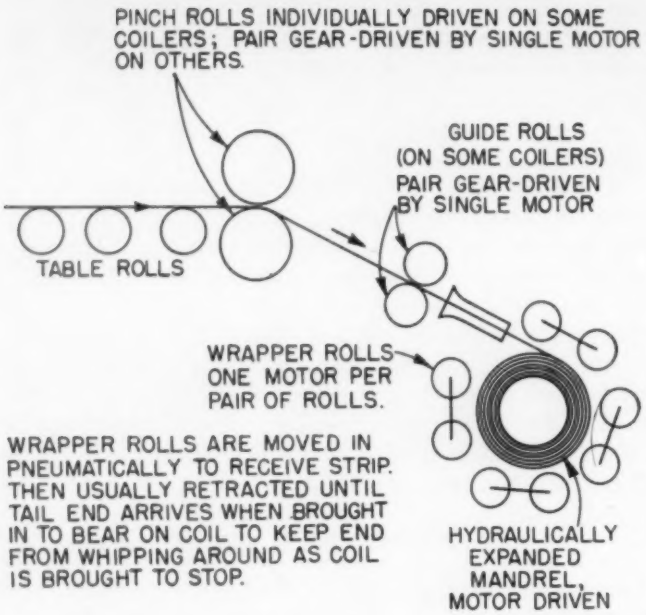

PINCH ROLLS INDIVIDUALLY DRIVEN ON SOME COILERS; PAIR GEAR-DRIVEN BY SINGLE MOTOR ON OTHERS.
GUIDE ROLLS (ON SOME COILERS) PAIR GEAR-DRIVEN BY SINGLE MOTOR
TABLE ROLLS
WRAPPER ROLLS ONE MOTOR PER PAIR OF ROLLS.
WRAPPER ROLLS ARE MOVED IN PNEUMATICALLY TO RECEIVE STRIP. THEN USUALLY RETRACTED UNTIL TAIL END ARRIVES WHEN BROUGHT IN TO BEAR ON COIL TO KEEP END FROM WHIPPING AROUND AS COIL IS BROUGHT TO STOP.
HYDRAULICALLY EXPANDED MANDREL, MOTOR DRIVEN

Figure 41 — Schematic diagram of mandrel type downcoiler.

COILER MOTORS

Special mill type wrapper roll motors, such as shown in Figure 6 near the beginning of this article were designed specially for coilers as early as 1937, with special flange mountings to fit the particular make of coiler. To combat severe operating conditions, the motors are designed to operate in a spray of water. The bearings are cartridge-mounted, grease-lubricated with pressure relief, spherical seat roller bearings being used on the drive end. Present day designs use glass and silicone insulation, and have 500 per cent momentary torque capacity. Motors of this design have been giving continuous service since they first were installed some 15 years ago. Adjustable frequency a-c motors used on some early coilers are no longer considered for new coilers. One mill builder now uses a foot-flange-mounted motor very rigidly supporting it in the wrapper roll assembly frame, radially outside each pair of rolls. Another mill builder now uses stationary mounted motors to drive the rolls through spindles. Coilers on above mentioned mill No. 2 are built this way. Figure 42 shows such a coiler using standard mill motors, rated 1-hour, 35-hp. The rms horsepower requirements are less than half that amount, thus making force-ventilation unnecessary.

Pinch roll motor horsepowers are, according to the above examples, at least half of those used on mandrels. The average ratio of pinch roll to mandrel horsepower of all such coilers is more nearly two to three. Some coilers have a one to one ratio. Theoretical considerations suggest that the average of two to three is not far wrong, although we must bear in mind that the one to two ratio coilers are doing a good job; and, the pinch roll motors do not overheat.

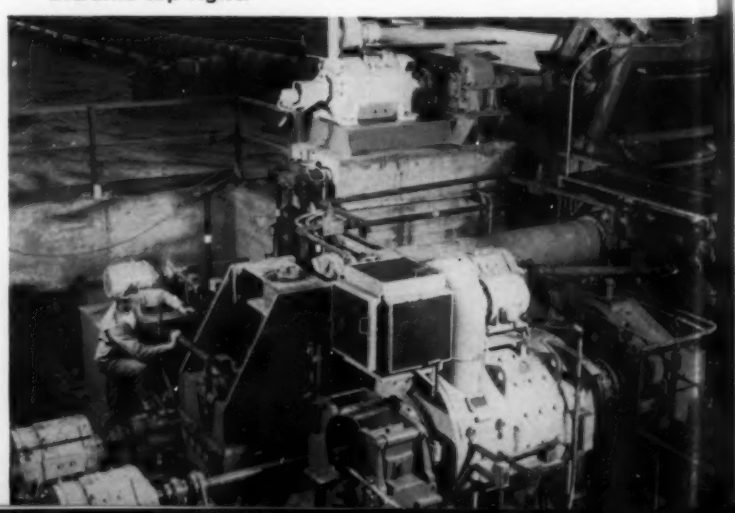
When coiling and after strip leaves the mill, the pinch roll motor becomes a drag generator exerting back tension against the mandrel. Then, as the tail end approaches the pinch rolls they alone plus whatever losses exist in the drive must match the mandrel motor torque. Based on such peak load requirements, it would seem that the pinch roll motor should carry approximately the same horsepower rating as the mandrel motor. There are several reasons why this is not true.

1. Overall losses are a factor. They may absorb 20 per cent of the mandrel power.
2. Actual rms horsepower requirements of the pinch roll motors are relatively low. This is because they are usually adjusted to carry only a small motoring load when the strip is in the mill and coiler at the same time. With the mandrel pulling against the mill the pinch rolls almost run idle.
3. Although there is considerable inertia in the pinch rolls, motors half as large as the mandrel motor do have sufficient torque to accelerate them quickly enough to match the responsiveness of the mandrel, with or without coil.

Such considerations, strongly supported by operating experience indicate that pinch roll motors should have between 50 and 75 per cent of mandrel horsepower ratings. Peak torque capacity when generating is particularly important in a pinch roll motor. Motors with so-called stabilizing windings should not be used because they become differential fields when the motor is pumping back power. Compensating pole face windings, or at least the proper shape of poles at the air gap to minimize the demagnetizing effect of armature reaction can be very useful in maintaining a high regenerative torque capacity in pinch rolls motors.

Speaking of both pinch roll and mandrel motors, it must be recognized that all motors have so-called "impact speed drops" which is an inherent tendency, upon sudden application of load, for speed to dip below and then oscillate briefly about the new steady state value. Some such transient behavior may occur in pinch roll and mandrel speeds whenever strip enters the coiler. Wide speed swings can cause trouble if, even for some small fraction of a second, pinch roll speed exceeds that of the mandrel — during an upswing of pinch roll speed, a dip in mandrel speed or both. It is then that the pinch roll will overfeed strip into the throat of the coiler — perhaps enough to create a cobble or to cause folded strip on the first few wraps. This has actually happened on one installation before the drive was tuned up. All this suggests that pinch roll and mandrel drives should both be "stiff", and be designed for a minimum of steady state speed regulation.

Figure 42 — Recent hot strip downcoiler installation has force-ventilated, 300-hp, mill type mandrel motor and holding brake in foreground; four 25-hp, non-ventilated mill type wrapper roll motors — two at extreme left, one at right, the other hidden from view; a force-ventilated mill type motor drives the large top "deflector" pinch roll, the bottom pinch roll motor is at extreme top right.



Mill auxiliary type motors perform very nicely on these pinch roll and mandrel drives. The larger motors have compensating pole face windings. Industrial type motors have also been used. Some engineers favor them, because in their opinion they have speed vs load characteristics superior to those of the mill type motors. This writer has not investigated to see whether or not there is a substantial difference one way or another. Whatever difference there may be is apparently of small practical importance in view of the very satisfactory performance of mill type motors. Standard off-the-shelf industrial type motors can hardly be expected to do the job unless mill type mechanical and electrical features are added. Therefore they become special and carry little if any price advantage over standard mill type motors with their particularly rugged frames, liberal sized shafts and bearings, twice the commutating capacity of standard industrial type motors, etc. Such considerations favor the trend toward mill type motors which so naturally belong in the steel mill.

COILER CONTROL SYSTEMS

In setting up the control of a coiler it must be recognized that the most important requirement is that of speed relationship. It is vitally important that proper speed relationship between pinch rolls, wrapper rolls, mandrel and the mill be maintained at all times.

Obviously, when strip is in the mill and coiler at the same time, the speeds of all components must be the same, with the exception of the wrapper rolls which may not then be riding on the coil surface. The running light speeds however, are the important ones, just prior to entrance of the strip. Whereas operating practice varies from mill to mill, the following running light speeds are typical:

Mill speed, fpm	**1800**	**1200**
Pinch roll running light speed, fpm	**1925**	**1285**
Mandrel running light speed, fpm	**2050**	**1360**
Wrapper roll running light speed, fpm	**2125**	**1435**

The amount by which any speed exceeds that of the mill is called "lead speed". Lead speeds used on the coilers vary widely, depending upon the product, the operators, the coiler, the tension, and the electrical equipment itself. Most coilers have at some time operated with lead speeds in excess of those above. There is less likelihood of cobbling the strip with excessive lead speeds than with zero or even negative lead speed; but, mechanical shocks are greater. Obviously, a coiler should not run slower than the mill, otherwise strip will pile up ahead of the pinch roll, and, if the mandrel should happen to be running slower than the pinch rolls, strip might pile up in the coiler throat and cobble.

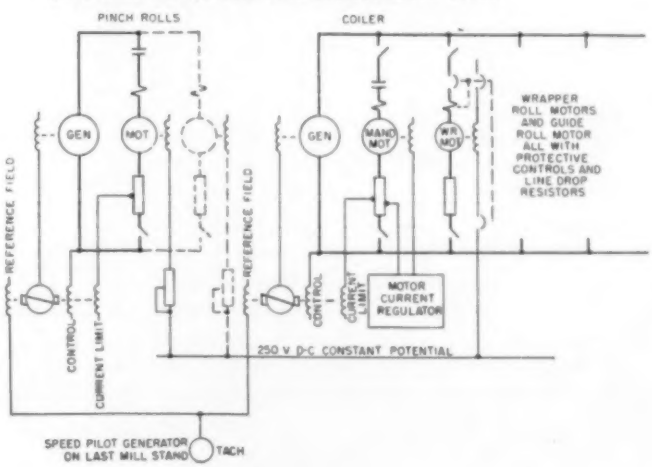
The runout table section at the pinch rolls usually runs slightly above mill speed, say 5 to 8 per cent. The pinch rolls need not run faster than this table section. Mandrel running light speed must be from 60 to 100 fpm above that of the pinch rolls to insure tension on the first few wraps when coiling short lengths which are not in the coiler and mill at the same time. The other reason for having mandrel speed higher than running light pinch roll speed is to minimize speed-up of the coiler when the end of the strip leaves the mill and the pinch roll motor swings from motoring to generating. Wrapper rolls should always have a running light speed slightly above that of the mandrel so that they will help the leading end of the strip around the mandrel. To run them slower than the mandrel will invite cobbles.

It is possible to coil strip with the pinch rolls running at, or even 2 or 3 per cent below, mill speed providing the running light speed of the mandrel is slightly above that of the mill. There may be a momentary but slight tendency for the strip to pile up just ahead of the pinch rolls until the strip reaches the coiler and is grabbed by it; but, the coiling from there on will be quite normal. The pinch roll motor may generate slightly and when the strip finally leaves the mill, the rise in speed as the pinch rolls go to full generating will be very small. This speed rise is an inherent characteristic of all such coilers. It may only amount to 100 fpm or it may be as much as 300 fpm. Where this is objectionable it can be reduced or completely eliminated in several ways. One difficulty which may arise when operating the pinch roll and the coiler at less than table speed is that the tail end of light strip will tend to candy and pile up just ahead of the pinch roll.

Constant tension is easily maintained within acceptable limits by regulating mandrel motor current with a conventional winding reel type of regulator which strengthens motor field with coil buildup. Extremely accurate regulation seems unnecessary according to field experience reported to date. During normal acceleration of empty mandrel, the current regulator is blocked out; and when up to speed a "weak field limit" keeps it from weakening the field in search for armature current. With adequate mandrel lead speed the entering strip will slow down the mandrel and the current regulator steps in to strengthen he field as the coil builds up until the tail end of the strip arrives and tension disappears. A field freeze feature then holds the field near its final value until coiler has been stopped, coil ejected and field reset initiated.

Regarding motor-generator sets, it is almost standard practice to supply the pinch roll motor or motors from

Figure 43 — Simplified schematic control diagram shows how the pinch rolls are on one generator and the mandrel motor with wrapper roll motors on another. Both generator voltages, as shown here, are regulated to the mill delivery speed; and, mandrel motor current is regulated to hold constant tension. On some coilers, the coiler generator is voltage-regulated to pinch roll generator or pinch roll tachometer volts.



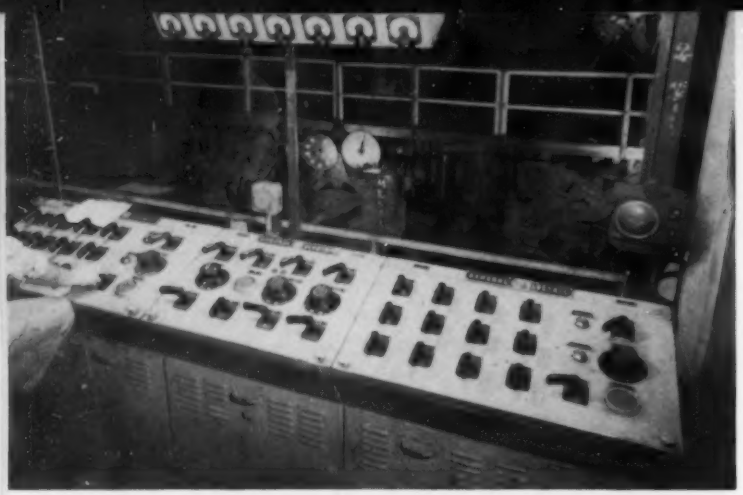


Figure 44 — A recently installed control desk for two mandrel type downcoilers.

one generator; and, the mandrel plus the wrapper rolls from another generator. Figure 43 shows this arrangement. It has several inherent advantages over the use of a common generator for the pinch rolls, mandrel and wrapper rolls. The following are but a few:

1. It is possible to stop and start with strip in both pinch rolls and coiler without serious loss of tension at low speeds and even standstill if necessary. The common generator system would (unless a pinch roll or mandrel circuit booster were added) mean loss of tension at the low speeds as well as at standstill; loose coil wraps would result and it might be difficult to avoid throwing loops in the coiler throat.
2. The mandrel and wrapper rolls can, with the two-generator arrangement be started and stopped quickly, as a unit, by current-limit generator voltage control quite independent of the pinch rolls which on many coiling operations continue to run as the completed coil is removed from the coiler. To do this with a common generator would introduce such complications as large accelerating contactors for the mandrel and wrapper rolls armature circuit; and, the performance would certainly not be as responsive and smooth as that with independent adjustable voltage control of the coiler proper (mandrel plus wrapper rolls).
3. The two-generator system has more built-in operating features and is therefore most adaptable to the various types of coilers and operating requirements in the industry.

Rotating type regulators are ideally suited for these drives. They are characterized by low control power requirements, they are highly responsive and provide such features as generator field forcing, voltage or speed regulation, current-limit, mandrel motor current (tension) regulation, and simple convenient adjustments at the control panels or operator's station.

It is only logical that present-day coiler installations call for automatic speed matching to the mill. This is done by voltage regulating the generators to the voltage of a speed-pilot generator on the last finishing mill stand, similar to runout tables. It is not necessary to actually regulate speed. Regulation of armature voltage is simpler as it considerably reduces stability problems. By including some mandrel IR drop compensation, this arrangement in reality performs the functions of a speed regulator.

There are at least two ways of obtaining automatic

TABLE VI

This tabulation of operators control switches, pushbuttons, rheostats and meters in a recently installed coiler pulpit serves as a convenient listing of the many functions performed by coiler equipments.

Left Desk Section (Coiler No. 1)	Meter Cabinet	Right Desk Section (Coiler No. 2)
Pistol grip type switches: Mill signal ***Table pinch roll adjustment **Wrapper roll sprays ****Side guide adjustments Coiler generator No. 1 control switch *Coil balance *Filter **Mandrel spray *Table pinch roll release *Shifter *Ejector *Mandrel expander **Coiler gate Coiler Master: "Off-Manual-Auto" Push buttons: Coiler "speed up" Side guide "short stroke" E — stop Rheostats: Tension adjusting	Coiler No. 1 amperes Pinch roll No. 1 fpm Finishing stand fpm Table A fpm Table B fpm Pinch roll No. 2 fpm Coiler No. 2 fpm **Center Desk Section** Pistol grip type switches: Pinch roll No. 1 generator Pinch roll No. 2 generator Runout table section A generator Runout table section B generator Pinch roll No. 1 master control Pinch roll No. 2 master control Table A control Table B control Pushbuttons: E — stop Rheostats: Runout table B speed Pinch roll No. 1 speed Pinch roll No. 2 speed	Switches, pushbuttons and rheostats on this desk section are same as those on the left desk section, except these are for coiler No. 2.

*110-v a-c Solenoid-controlled pilot-operated air pistons.
**110-v a-c Solenoid-controlled pilot-operated hydraulic pistons.
***440-v a-c Motor.
****250-v d-c Constant potential.

speed matching with the mill. One is to regulate both pinch roll generator and mandrel generator to that of the mill speed pilot generator. The other is to regulate only the pinch roll generator to that of the mill pilot and then in turn to regulate mandrel generator voltage to that of the pinch roll generator or a speed pilot on the pinch roll motor itself. The latter method makes the mandrel a slave to the pinch roll. Thus, in order to stop or even reverse the coiler it is only necessary to stop or reverse the pinch roll. This has certain advantages to the operator. It also takes from the operator the responsibility of seeing that the proper speed relationships are maintained between the pinch rolls, mandrel and wrapper rolls. They are set once and for all at the control panel. It has the disadvantage of adding a small component of speed rise when the strip leaves the mill. At least five coilers are operating this way.

As far as control desks are concerned, there are as many different ones as there are coiler installations. The functions which must be performed are, however, very much alike. Figure 44 shows a two-coiler desk. The devices are listed in Table VI. Such a listing perhaps describes better than any other method the functions of a coiler. It will be observed that there are many essential solenoid controlled operations which have not yet been mentioned.

Sometimes several functions are combined in one control switch; for example, there are some installations where the vertical operating lever type coiler master switch has five positions as follows:

"Strip — Mandrel Collapse — Stop — Mandrel Expand — Run"

The operator can flip his switch from one extreme position to the other and all the necessary operations will, through suitable limit switch interlocking, occur in proper sequence.

Small solenoid operated "pilot" valves (see Figure 45) are now commonly used in which small solenoids control pilot valves which in turn air-operate the main valves. Currents taken by these are approximately one-tenth as high as required by the direct acting valves. Such small holding currents can be handled directly by pistol grip control switches, push buttons, etc., thus obviating the need for contactors. This is not always done however because the inclusion of contactors lends flexibility for interlocking circuits. Some users prefer d-c valves. Most however use 110 volts a-c for valve solenoids.

With final reference to the d-c control, there are the wrapper roll motors which "ride along" with the mandrel on its generator. Here is another case where individual motor protective equipment is necessary. One panel will usually mount, for all four or five motors, such devices as: field loss relays, shunt field resistors, line contactors, dynamic braking contactors and resistors, line resistors, ammeters and circuit breakers for disconnecting one side of the armature and both sides of the shunt fields.

COILER CONVEYOR

Adjustable speed mill type motors with constant potential control are the customary choice for coil conveyors. This is in reality a constant torque type of application and could therefore use adjustable voltage control. Since the total horsepower requirements of a conveyor drive are generally between 25 and 50, it is so easy to simply employ an adjustable speed motor perhaps slightly over size, and to use standard constant potential control.

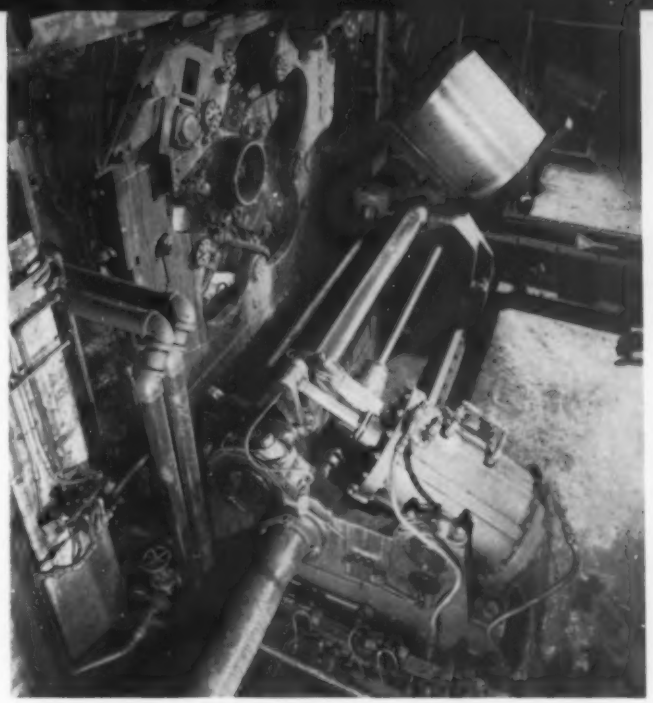


Figure 45 — View shows air-operated, coil tilter placing coil on conveyor. The two tilter air cylinders are visible in the front and back. The small solenoid operated air valves are shown at bottom. No. 1 coiler has just started a new coil and wrapper rolls are still in.

A considerable amount of limit switch interlocking is necessary on these drives to coordinate their operation with the coiler unloader, coil weighing device, automatic transfers, downender, push off, etc. Solenoid controlled hydraulic and air valves are used extensively here, and at the coilers.

PILER

The electrical equipment for a piler consists of nothing more than an adjustable speed motor and control to drive the pinch rolls which feed the sheared lengths to the piler. Speed control is necessary in the form of a rheostat on the operator's desk. Adjustable voltage control might be used, but usually the range of speed used for shearing is relatively narrow and an adjustable speed mill type motor with constant potential control is entirely adequate.

SUMMARY

Probably no industry demands as much in reliability and performance from its electrical equipment as does the steel industry. That is why we have "mill type" motors and "mill type" controls — built to meet the highest standards of endurance and performance. No mill in the industry demands more than the hot strip mill. This has always been so; and, will no doubt continue to be so in the more highly competitive years ahead. Steel mill requirements have been a challenge to the designers of electrical equipment; and, anyone who has witnessed the operation of a 2000 fpm hot strip mill must conclude that the challenge has been ably met. This was possible only through the combined efforts (working together) of mill builders, electrical equipment manufacturers and steel mill engineers.

PICTORIAL ROUNDUP

1

2

3

4

5

AISE Western Meeting

LOS ANGELES, CALIFORNIA

February 20, 21, 22, 1956

The third AISE Western Meeting, and the second to be held in Los Angeles, found a total of 469 registrants lining up (1). Of these 96 came from east of the Mississippi, 250 from the Los Angeles area, and 123 from other areas west of the Mississippi (chiefly from the San Francisco area). Plans for handling Monday's meetings were lined up at an early breakfast on Monday morning (2). Those attending the meeting found the papers interesting and valuable. On Monday morning's program were (3) J. I. Greenberger, John J. Stolz, M. P. Klick, and chairmen E. C. Thomas and W. T. Purvance. There was a great deal of interest in the annealing symposium on Monday afternoon which was carried out by (4) M. D. Baughman, Jr., E. B. Fitzgerald, T. G. Simison, Horace Drever, and J. M. Murphy (C. E. Peck is missing from the photo). Tuesday afternoon's electric session (5) found M. C. D. Hobbs, Harold E. Watson, Charles C. Brandt, E. F. Donatic, A. C. Parsons, and F. E. Fairman III on the platform. Sparkplugs in AISE activities were officers from the San Francisco and Los Angeles sections (6) E. C. Thomas, G. W. Teskey, Jr., E. F. Donatic, and Ruben Finkelstein (standing). Four AISE secretaries were present (7) Phil Ashurst, Detroit; Linn Morrow, Philadelphia; Jim Kinney, Los Angeles, and Jim McCormick, San Francisco. Sessions were very well attended (8). In (9) AISE president Bill Collison (center) is seen talking to W. J. McClung, vice president —operations, Bethlehem Pacific Coast Steel Corp. (at the left) and Alden G. Roach, president, Columbia-Geneva Steel Division, U. S. Steel Corp. Also caught at the meeting were (10) H. H. Fuller, president, Bethlehem Pacific Coast Steel Co. talking with John L. Young, vice president — engineering, U. S. Steel Corp. The speaker at the informal dinner was W. J. McClung who is shown here (11) being congratulated by Bill Collison, AISE president. In (12) are seen a few of those attending the informal banquet. About 105 made the inspection trip through the Los Angeles plant of the Bethlehem Pacific Coast Steel Co (13). Observing work done at this plant in eliminating atmospheric pollution was one of the high spots of the trip (14).

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Seamless Pipe For The Oil Fields

. . . . as the oil driller has had to go deeper and deeper in his constant quest for oil supplies, better and stronger steel tubing has been necessary . . . . the tubemaker, through his constant development of better and stronger steels and improved rolling practices to minimize defects and give more uniform tubing, has been an important factor in making available an ample supply of petroleum products . . . .

▲ THE subject for this paper is a very broad one and certainly cannot be covered in any great detail in any one paper; however, it will be possible to touch on some of the high points.

It should be pointed out that products of the seamless tube mills have a great many applications, and that the writer's experience is confined to the production of oil well tubing and casing, known as oil country tubular goods and is generally referred to as pipe.

Both casing and tubing are furnished to the trade threaded and coupled and are used in the completion of oil wells. Tubing sizes range up to and including 4½ in. outside diameter, while casing starts at 4½ in. and progresses upwards. The seamless mill at Pueblo is designed to produce tubing from 2⅜ in. OD to 4½ in. OD and casing 4½ in. to 9⅝ in. OD.

Casing is used in oil wells to support the walls of the drilled hole, exclude water, etc., and may or may not be cemented into place. Tubing is used to get the oil from the well and is suspended inside of the casing.

Drilling activities in the United States have increased greatly in the past few years, due to the increased demand for petroleum products, and in the search for oil it has become necessary to go deeper and deeper into the earth's crust. This has brought on a demand for higher strength materials designed to withstand the increased pressures encountered at these greater depths. The average depth of wells today is over 4,000 ft, while a few years back this depth, for a single well, would have been considered out of the ordinary.

At the present time, wells are being drilled where such high pressures are encountered that they have had to be shut in and abandoned, since there is no pipe available of sufficient strength to make a completion. This offers a very serious challenge to the steelmaker to provide a suitable material for these deeper wells at a reasonable cost to the oil driller. Some progress is being made along these lines, but the steel producers are hard pressed to keep up with these developments.

Before discussing any of the further aspects of this pipe, the writer would like to take a few minutes to describe the sequence of operations as used at our mill.

THE PROCESS

Heating—Round billets of the proper length and diameter to make the size and length of pipe desired are charged into a rotary hearth furnace. This furnace consists of four zones, the first three zones are heating zones while the fourth zone is used for soaking.

The steel rounds are gradually brought up to the working temperature, which varies with the grade of steel to be heated, but is usually in the range 2200-2300 F. The atmosphere is slightly oxidizing.

The charging mechanism places the billet on the revolving hearth which carries it around through the various zones to the discharge door, which is adjacent to the charging door. The speed of the hearth may be varied and is set for a heating rate of 15 to 20 min per in. of billet diameter. It is most important that the billets for processing into seamless tubes are heated evenly throughout to assure the proper displacement of metal during the piercing operation. If not uniformly heated, eccentric walls will result in the piercing operation and this condition cannot be corrected in the later operations.

Piercing—The piercing mill consists of two rolls which have the same direction of rotation and are set in the mill housings so that their axis are at an angle to one another and the center line of the mill. These rolls are barrel shaped, having a crown at or near the center of their body. From this crown the surface of the roll is tapered toward each end. The inclination and the angularity of the rolls are necessary to produce the play of forces required for piercing. Rolls are adjustable laterally in their housings by means of motor driven screws and are set so that the distance between them at their maximum diameter or crown is always a definite amount less than the diameter of the billet to be pierced. The angle is also adjustable by means of manually operated screws and wedges. The angle at which these rolls are set determines the speed of piercing.

The billet is supported in the pass by two steel guide shoes which fit the contour of the rolls. The lower guide is stationary and the top guide is adjustable vertically by motor operated screws. The object of these guides is to hold the billet being pierced in the pass and to control the outside diameter of the rough tube hollow.

Before a billet is pierced, a mandrel is inserted in the pass from the delivery side of the mill. This mandrel resembles a cone and is called a piercer point. The point is set so that the pointed end extends beyond the maximum diameter or crown of the rolls and is held in position by a water cooled bar which is the same diameter or slightly less than the diameter of the piercer point.

A billet thoroughly heated is taken from the furnace and delivered into the trough at the inlet of the mill, it is then pushed into the mill by means of an air operated ram or pusher. The rolls grasp the hot billet, revolves it rapidly and pulls it forward a short distance where it comes in contact with the piercer point. The compression exerted by the turning rolls forms the solid billet over the piercer point, the result being a semi-finished tube with a comparatively heavy wall.

The mill is equipped with two of these mills which are identical in construction and operation, so that, if necessary, the tube may be double pierced. Our practice is to double pierce anything 5½ in. and larger. The object of double piercing is to permit the piercing of tubes with larger outside diameter and lighter wall thickness than is possible with a single mill. The first piercer forms the solid billet into a hollow, the second mill expands this hollow, decreases the wall thickness and irons out any irregularities made in the first mill.

A reheat furnace is provided ahead of the next operation, "Rolling," and is used as the demand arises.

Rolling—The plug mill is similar to conventional bar mills except it is two high only and has full circular passes when placed one above the other in its housings. The rolls have four to seven grooves, depending on the groove sizes. The top chucks and roll are supported by four heavy bars which run down through the mill housing and rest on counterweights. This permits the top roll to be raised approximately 1½ in. by means of a tapered wedge which is actuated by compressed air to allow stripping of the tube from the bar. The top roll is adjusted vertically by means of motor operated screws.

A receiving table with a "V" trough is located at the entry side of the mill and is adjustable so it can be positioned directly in line with any groove in the plug mill rolls. The back tables are the bell type and evenly spaced, one behind the other, directly in back of the roll grooves. The plug mill bar, securely fastened in the support at the rear of the back table, projects through these guides into the roll pass. Since it is necessary to pass the tube more than once through the roll groove, some means must be provided for removing the tube from the mill bar and returning it again to the entering side. For this purpose, a set of rolls is placed between the first back table guide and the main rolls. These rolls are considerably less in diameter and the grooves which they contain are the same size and directly in line with the main roll grooves. The top roll is stationary while the bottom roll can be raised to strip the tube from the bar. These rolls revolve in an opposite direction to the main rolls.

When the rough tube is delivered from the piercing mill or reheat furnace to the entry table, a mandrel, called a rolling mill plug, is inserted in the end of the mill bar which supports the plug in the center of the roll pass. The tube is then pushed into the groove by means of a ram which is actuated by compressed air. This ram exerts sufficient pressure to force the entering end of the tube over the plug, permitting the rolls to grip the tube and pull its full length over the plug. As soon as it is passed through the groove, the plug is removed from the bar, the top roll is raised, and the return rolls on the outlet side of the mill are brought to bear on the tube which is returned by them to the entering side. The tube is then turned through an angle of 90 degrees to roll the metal at the opening of the roll groove in the first pass. The tube is then given a second pass through the mill in a similar manner, and a third pass, if necessary. In this way the wall of the tube, supported by the plug from the inside and subjected to the action and pressure of the rolls on the outside, is reduced in thickness to the gage required and the tube is proportionally lengthened and reduced in diameter. The tube now has a uniform wall thickness throughout, but is slightly out of round, not perfectly straight, with some scale on the outside surface and light scratches on the inside. In order to remove these latter defects, the tube is then delivered to the reelers.

Reeling—These mills consist of a pair of short heavy rolls which, when set in the mill housings, have their axes at an angle to one another and the center line of the mill. Both rolls have the same direction of rotation. The shape of the rolls resembles the piercer rolls except they have a longer flat working surface and the inlet and outlet angles are less. Rolls are set so that the distance between them at their centers is slightly less than the rolled tube's outside diameter. The tube is supported in the pass by two cast iron guide shoes and answer the same purpose as the guide shoes in the piercing mill. A mandrel, known as the reeler plug, which is slightly larger than the rolled tube's inside diameter, is inserted between the rolls and is held in position by a bar so that the face on the plug coincides with the working surface of the rolls. The tube, which still retains enough heat, is delivered from the rolling mill where it is mechanically conveyed into the reeler rolls. When the tube is contacted by the rolls, it is revolved rapidly and drawn forward over the plug. The plug being larger than the tube's inside diameter, expands the tube. When the tube leaves the mill it is fairly straight and has a smooth burnished surface inside and out and a reasonably round outside diameter.

Production from the reeling machine is somewhat less than the rolling mill, and two of these machines are necessary to service production coming from the rolling mill.

Sizing and Reducing—This operation involves passing the tube through a series of roll stands arranged on the continuous plan to obtain the final outside diameter. The roll housings are inclined 45 degrees so that each stand lies at right angles to each other and the center of the grooves.

At C F & I two mills are employed, a seven-stand

sizing mill and a fourteen-stand reducing mill. The mill used depends upon the outside diameter of the reeled tube and the finished outside diameter of the pipe. Pipe 4 in. and larger is rolled in the seven-stand mill without re-heating. Pipe 3½ in. outside diameter and smaller is passed through the fourteen-stand mill after being re-heated in a series of 15 barrel-type furnaces set in line with the mill. The tube is conveyed through these furnaces by motor driven rollers located between each heating chamber and the speed of the tube through the furnace is set to coincide with the speed of the first roll stand.

The pipe, after cooling, is sent to the finishing floor to be made into a finished joint of pipe. This involves straightening, cropping, threading, and testing, and for some products involves upsetting and heat treatment.

SPECIFICATION REQUIREMENTS

In the production of oil well tubing and casing, four grades are in demand at the present time. Three of these grades are defined under American Petroleum Institute Specifications and are designated as H-40, J-55 and N-80. The other grade of high strength, known as P-105, is now in use, although it has not been adopted by API as standard at this time.

These grades denote physical requirements and the number following the letter denotes the yield strength in thousands of pounds. H-40, for example, denotes a 40,000 psi yield strength. The processes used to obtain these physical requirements are left to the discretion of the manufacturers and the practices followed for each grade may vary widely, especially for the high strength pipe.

H-40 casing and tubing are finished in the hot rolled condition without further heat treatment to produce a pipe which has a minimum yield strength of 40,000 psi, a tensile strength of 60,000 psi with an elongation of at least 27 per cent. The steel used at our plant to meet these requirements falls within the AISI grade C-1038.

J-55 casing, the most popular grade at the present time, is finished from hot rolled pipe with a minimum yield strength of 55,000 psi, a tensile strength of 75,000 psi with an elongation of at least 20 per cent. This pipe is produced from steel of 0.40 to 0.45 per cent carbon and 0.90 to 1.20 per cent manganese.

The physical requirements for both N-80 casing and tubing are a minimum of 80,000-psi yield strength, 100,000-psi tensile strength with at least 15 per cent elongation.

Two different processes are used to produce N-80 grade at our mill. N-80 casing is produced from plain carbon steel with an analysis similar to AISI Grade C-1035. In order to obtain the required physical strength, the pipe is quenched and drawn in a specially designed heat treating unit.

N-80 tubing is produced from a steel of 0.40 to 0.45 per cent carbon, 1.30 to 1.60 per cent manganese with 0.20 per cent molybdenum. After the tubing has been upset it is then normalized.

Some might ask, "Why are two different methods employed for the production of grade N-80?" It would be highly desirable for us to produce both casing and tubing by the quench and draw process, since this grade can be made from plain carbon steels; however, practices have not yet been developed whereby the physical properties of the upset ends of tubing are equivalent to the body of the pipe using the quench and draw process and it is therefore necessary to rely on a composition which can be normalized.

Another point in favor of the quench and draw process is that the new grade P-105 can be produced economically, whereas it is questionable whether an alloy can be developed that will meet all of the requirements and still be reasonably priced for use in the oil fields. The designation indicates that P-105 specifications must meet a minimum yield strength of at least 105,000 psi.

Other than the above physical requirements, the specification requires a flattening test which is essentially a bend best and a hydrostatic test where each joint of pipe is filled with water to some designated pressure, normally 3,000 psi water pressure for H-40 and J-55 grade, and in the case of N-80, sufficient water pressure is applied to stress the pipe to at least 80 per cent of the yield strength. In this connection, pressures up to 10,000 psi may be necessary.

In designing strings of casing and tubing, three main factors are taken into consideration; (a) bursting strength, (b) collapse strength and (c) tensile strength, which usually evolves itself into joint strength. The specification and testing, as just described, are built primarily around these design factors.

High internal pressures are encountered after the well has been completed and the casing or tubing becomes filled with gas or oil.

External pressures, caused primarily by the weight of the mud column used during drilling, may vary considerably, depending upon the density of the mud and the depth of the well. Wells 10,000 ft deep may exert pressures of 5,000 psi or more, and there are wells producing at the present time from a depth in excess of 17,000 ft.

Testing for collapse strength requires specialized and expensive equipment and even with the latest type of machines available it is a time consuming operation. The testing for collapse is not required under present specifications; however, bulletins are published by the API showing the values for the different sizes and grades of pipe and, of course, the man designing a string of casing does rely on these figures using his own factors of safety.

Tensile and joint strength are extremely important factors in design since the casing or tubing is suspended from the top of the well. In order to increase joint strength in tubing, the wall at the threaded ends of the pipe are externally upset so that it is approximately one-half again as thick at this point. Casing is furnished in two different thread lengths, the longer thread is somewhat more expensive but does offer a higher joint strength.

QUALITY

Size, length, wall thickness, threading tolerances, etc, are all listed in API specifications and there is no need to discuss them here; however, the writer would like

to point out one difference that we have observed in the API specifications. Not only does the specification cover tolerances on threading, but also writes a specification for the inspection of these threads. This specification indicates the types of gages to be used and the tolerance for these gages. Certified master size gages are required, which are used for testing the accuracy of the working gages. These gages are recertified yearly. So much for this phase of quality.

The very nature of the seamless process demands the use of the highest quality steel. Seam, piping, segregation or other impurities, which may not be objectionable or apparent in other applications, cause considerable trouble in the manufacturing of seamless products. In the piercing operation, the tendency is to exaggerate any defects that may be in the steel rather than to minimize them or even eliminate them, as there is a tendency to do in most other operations.

It may be well to mention at this point that API specifications define an injurious defect as one having a depth no greater than 12½ per cent of the nominal wall thickness. If any defects are present on the interior surface of the pipe, this depth is extremely difficult to determine without destroying the pipe. Those on the outside can be determined by grinding. In any event, defects of any kind are costly and must be eliminated or at least held to a minimum for an economical operation.

INTERIOR DEFECTS

Interior defects may have several sources in tubular products. Pipe may or may not be objectionable depending upon its characteristics. For example, pipe that is free of slag and other extraneous material may have no detrimental defects on the interior surface of the pipe. If slag is present, the piercer point is often ruined, and if encountered as the billet starts through the mill, its effect is shown through the entire length of the hollow. Spongy centers are extremely detrimental, since they tend to build up on the piercer point as the billet is pierced and result in interior defects in the pipe. The subject of piping and its detrimental effect on the piercing operation is a controversial one, and there are as many ideas on the subject as there are people involved. The job of controlling interior conditions of the steels falls, certainly, to the open hearth operators.

Interior defects may also be caused during the piercing operation by improper mill settings. If the mills are set with too much draft or insufficient point lead, the steel is fractured ahead of the point, resulting in an interior defect. Badly worn piercer points may also be a source of interior defects.

Interior defects usually do not show up in the pipe until after it has received final sizing. In this operation the hollow is not supported from the inside and as the pressure is applied to the outside, these defects fold inwardly and can be easily seen on the inspection table.

Inside scratches can be caused at the plug mill, but do not have the same appearance as the defects mentioned above. This condition can easily be corrected through the proper use of lubricants and plugs that are in good condition.

EXTERNAL DEFECTS

All seamless mills are plagued at one time or another with seams in the pipe surface which are caused by steel of poor quality. If someone could find a simple and economical solution to this problem, his fortune would be made.

These seams usually appear on the pipe in the form of a helix in much the same manner as the red and white stripes twist around a barber pole. This is due to the tapered roll in the piercing mills which causes the billet to twist during piercing. The more the billet is worked in the piercing mills the tighter the twist. Sometimes, when double piercing, these seams may appear straight, since at our mill one piercing mill turns to the right and the other to the left.

In addition to being twisted, the steel is usually expanded at the same time further exposing any defects that may be in the steel. It can be readily seen that if defects are present they will show up at this operation.

All operators producing steel for the seamless mills are faced with problems of furnishing a billet free of external defects at a reasonable cost. There have been several approaches to this problem, especially in the way in which the steel is conditioned prior to rolling at the seamless mill, and before concluding this paper, the writer would like to mention a few of the practices that are followed. Bear in mind that each plant has inherent differences and the amount of conditioning necessary may vary a great deal.

The simplest conditioning practice that the writer has witnessed is where blooms from the blooming mill were first descaled and then visible defects removed, using a hand scarfing torch. The blooms were then rolled into rounds and charged into the furnace at the seamless mills without further conditioning. Certain steels, especially those of higher manganese and those containing molybdenum, which cannot be hand scarfed, are conditioned with a gage or billet conditioner.

A variation of this practice is to completely peel the bloom with a hand torch, pickle to remove all scale and then re-scarf any defects that may remain.

Still another variation is to peel the blooms by hand scarfing, roll them into rounds then scarf any defects from the rounds.

Hot deseamers are also used on some mills and after deseaming the rounds, blooms are then conditioned using a hand torch.

The practice of mechanical peeling the round billets is used at several plants. In this operation, the billet surface is removed by passing the billet through a revolving head equipped with cutting tools. The amount of metal removed is usually varied with the size round being peeled, and the quality of the steel, and may be up to $\frac{3}{16}$ in. on the diameter. After peeling, the remaining defects are removed by scarfing or chipping depending on the steel grade.

Other external defects may be caused during the rolling or heating at the seamless mills and include pits, scabs, guide scratches and others too numerous to mention.

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Design Factors for Steel Mill Tractors

. . . . it is extremely important to select the proper equipment for material handling operations . . . . too much emphasis cannot be placed on the necessity of maintaining a well organized material handling system . . . . the industrial truck industry has well met this challenge for its field of material handling operation . . . .

▲ MATERIAL handling, and the benefits to be gained therefrom, are as relative to the smallest companies as they are to the largest. It has already been established that the average plant spends as much as 40 per cent of its payroll for handling material, a truly prohibitive cost for operations that add nothing to the value of the product. And even more serious, some companies are spending up to 60 per cent for such daily tasks!

Obviously, in today's highly competitive market, profits in large must come from lower production costs, and the reduction of such costs can come only with more efficient, more economical handling techniques, and the careful selection of the equipment to do the job.

Material can be handled manually and it can be handled mechanically. Comparison can be made of these two methods, not only in terms of cost, but also increased safety, speed of operation, improved employee morale, and the like.

The average man can lift a maximum of only 80 lb and raise it no more than waist high without personal injury. If he loads a hand truck, he cannot push it faster than 125 fpm. On the other hand, a typical heavy-duty powered industrial truck can lift a load weighing more than 10 tons, transport it three or four times as fast, and spot it at floor level or eight to 12 feet in the air.

In addition, powered equipment can do the job of several men, freeing such personnel for more productive jobs within the company. And of course the handling job will be done with greater safety and with direct savings from reduced compensation claims.

For convenience sake, it is wise to categorize handling equipment used in steel mills and related heavy industries, in three main groups.

1. For continuous movement of goods from one fixed point to another, conveyors are fastest and most efficient.
2. To move goods intermittently over an area within the boundries of fixed points, overhead travelling bridge cranes, jib cranes and the like, are most suitable.
3. For moving loads intermittently or continuously between many points without regard to fixed stations, powered industrial trucks are by far the most effective.

Since our background and experience lie within the field of powered industrial trucks, this discussion will detail just such equipment. This report will cover three topics: (1) general types of industrial trucks used in steel mill operation, their operating characteristics, advantages, and limitations; (2) operation, maintenance, and safe use of such trucks, together with the production problems surrounding their effective application, and how these factors influence general truck design; and (3) various standard and special trucks which have been designed specifically for the steel and related heavy industries by different manufacturers.

One thing should be remembered in any discussion of handling equipment. Manufacturing and processing techniques in the iron and steel industries are far from static; there are time intervals in all stages of processing which cannot be appreciably shortened. Consequently, if time is to be saved, it is generally the time required for necessary movement of material, either from a set location or from one stage of production to another.

Briefly, industrial trucks are most often utilized for: (1) handling coils in a hot strip mill; (2) handling coils in a cold-reduction area; (3) handling coils in a temper mill; (4) delivering coils for tinning to the electrolytic lines; (5) delivering tinned coils to flying shears, where such operations are not an integral part of the electrolytic line; and (6) moving coils to the continuous furnaces in the annealing area; (7) carloading; (8) storage of coils and sheets, etc.

As indicated previously, conveyors hasten the movement of steel between certain successive operations, while overhead cranes provide for intermittent handling of loads within certain defined areas. Remaining is a multitude of other handling chores performed most effectively by powered industrial trucks.

The principle that has led to the widespread adoption of industrial truck handling is often called the principle of load units: the more pieces, pounds, or cubic feet of material combined in one unit and moved without breaking bulk, the lower the handling cost per piece, pound, or cubic foot.

This same principle makes railroad carload shipments cheaper and faster than shipments of less than carload quantities, but it is already subject to the qualification that labor and other costs necessary to make a larger unit should not exceed the savings it makes possible.

Let us then consider the various types of powered rolling equipment normally found in steel mills and related steel handling and fabricating industries. It is well to remember that such equipment, while beneficial within its own scope of handling, may often be even more effective when, integrated with other equipment, it becomes part of a smooth functioning handling system.

Fork trucks are one of the most popular types of industrial vehicles and are designed for both horizontal and vertical handling. The most common type of load carrier used in conjunction with such vehicles is the pallet, although skids, skid bins, and other containers may be likewise utilized. However, since the forks require only a minimum of vertical clearance for picking up loads, it is possible to use the shallower and lower cost base or support, such as the pallet. The fork truck is characterized by cantilever load suspension and requires a considerably heavier truck for handling the same size load as compared to its companion high- or low-lift platform truck.

High and low lift platform trucks are normally utilized where medium to long moves are involved, averaging from 350 to 700 ft, with or without stacking. Low-lift models are used only for horizontal moves with the platform lift sufficient just to clear the skid load from the floor. High-lift trucks are utilized where stacking is required in addition to the horizontal travel. A distinct feature of these trucks is that because the front wheels are under the load, a lighter overall vehicle may be used to carry any given load. More equal distribution of the total weight of the truck plus the load is also important in restricted floor loading areas. As indicated, pallets cannot be used because of the depth of the platform, and in their place are skids or skid bearing containers.

Tractor-trailer trains are normally prescribed where large volumes must be moved over long distances, usually more than 750 ft. Trains consisting of industrial tractors and standard floor trucks or trailers, are essentially a haulage system rather than a selfcontained handling system. Often a fork truck will place full pallet loads on the trailers which, at their destination, may be mechanically removed and handled as normal load units.

Mobile cranes are highly advantageous because of their ability to reach over high stacks and other inaccessible objects to pick up or deposit a load. They are also designed to carry unusually long and/or bulky loads, in many cases parallel to themselves, to negotiate narrow aisles and crowded areas.

Straddle trucks are specially designed for use in handling large bulky loads. While such vehicles have the advantage of providing greater stability in handling such loads along with a better floor load distribution, they require considerable space between adjacent loads for loading and unloading. Then too, loads must be placed on blocks, called boosters, to enable the arms of the trucks to reach beneath them for pickup.

Many of the basic trucks may be altered slightly with attachments to enable them to perform certain operations with greater flexibility.

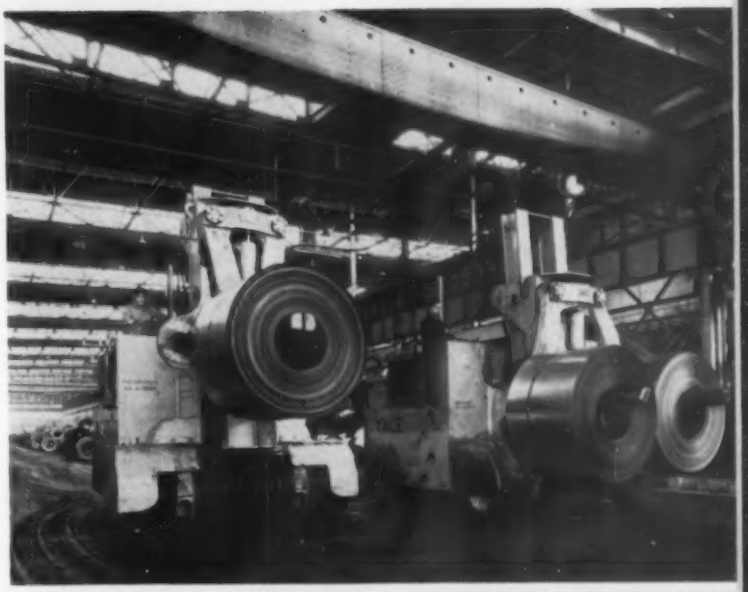

Figure 1 (top) — The basic ram truck has, to a large extent, become the heart of the steel coil handling system. These particular machines have power operated split rams to increase their flexibility.

Figure 2 (center) — These particular machines have a capacity of 40,000 lb and are equipped with a power operated side shifter attachment. This special attachment increases the maneuverability of these large giants and aids in decreasing the loading and unloading time by faster spotting of the load.

Figure 3 (bottom) — The straddle carrier is also used to transport steel coils.

For example, the ram truck employs a single ram in the center of the carriage in lieu of the two forks, and is used primarily to transport coils. Operated by one man, the ram truck provides both horizontal and vertical handling. Found principally in steel mills and heavy metalworking plants, it is designed to handle loads up to and in excess of 60,000 lb, with 30,000 and 40,000-lb trucks common in many mills. Smaller models of these trucks handle lighter loads from 10,000 to 20,000 lb.

The upended is another ramification of the standard fork truck and has power rotating forks designed to up-end coils and also when used on the smaller capacity trucks, to up-end scrap boxes.

The automatically operated tin-plate clamp is used in conjunction with a fork truck to prevent sheets of steel plate from slipping from the forks or telescoping after a sudden stop or turn. A new device recently placed on the market utilizes an electric magnet to hold the load against the vertical fork back.

One of the most important recent developments in handling equipment for the steel producing and fabricating industries is the coil clamp which handles large steel coils in the same effortless manner that rolls of paper have been handled in the past. Trucks equipped with these clamps instead of conventional forks or a ram, can pick up coils weighing up to 15,000 lb, in either a horizontal or vertical position, change their position a full 360 degrees while in transit, then deposit them in any place or position desired. Performance tests of such vehicles now in operation have been very encouraging and indicate a rapid future growth of this new handling technique.

We have covered so far some of the general types of equipment to be found in the steel mill. Let us now consider some of the problems which the industrial truck manufacturer must consider when building the kind of equipment to best meet the special needs of this industry.

It is best to group the many problems into three specific categories: safety, maintenance, production.

While these problems are not peculiar to the steel industry alone, it may be said that those factors have greater significance in this particular industry and that these problems have played a major role in developing the trucks used in steel mills today.

That material handling and safety engineers are closely related is well appreciated. In the whole field of industry, there is no place where safety and efficiency are so intimately associated as in handling operations.

Statistics show that about one of every four disabling accidents is the result of improper material handling, and unfortunately, in the steel and related heavy industries, this ratio is undoubtedly higher.

Safety in material handling presents two main problems: one is the men on the job; the other is the equipment used. The manufacturers of industrial trucks have met the challenge of this industry and have done much to promote safety in truck operation through the design and construction of trucks, and such equipment as warning devices, guards for operating end-platforms, guards over the wheels, guards over moving chains, cables, etc.; safety control brakes, locks for forks, proper enclosures for electrical equipment—these and many more devices are making industrial trucks as safe as possible.

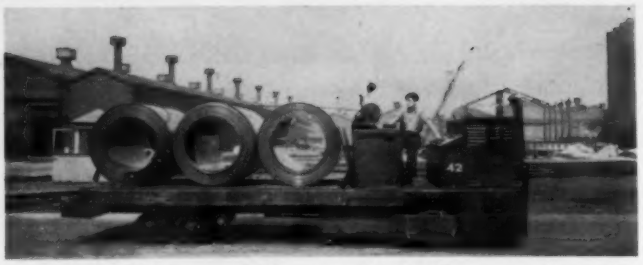

Figure 4 — This machine is principally a load carrier equipped with a conveyor platform to facilitate the loading and unloading operation. Here the truck has just picked up a load of three 20,000-lb steel coils for a gross load of 60,000 lb.

Figure 5 — A typical 2 or 3-ton fork truck is equipped with a special boom and magnet attachment for steel plate handling.

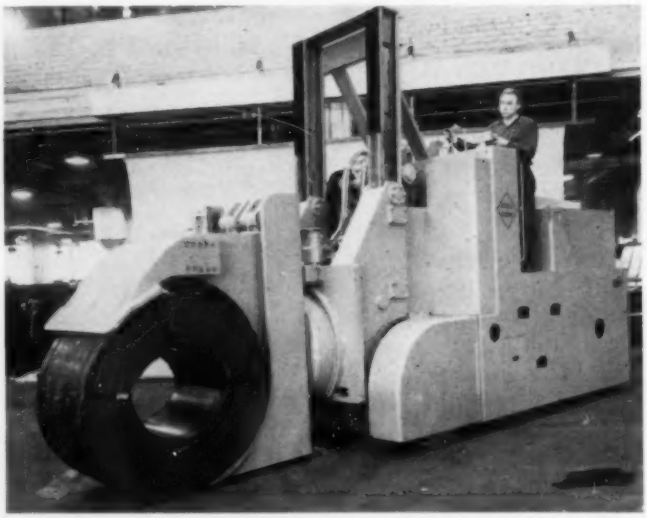

Figure 6 — The clamp picks up a coil from the horizontal position. Once the coil is firmly grasped it can be rotated a full 360 degrees as required in either direction, and deposited in either an upright or horizontal position at its destination.

Visibility for the operator, one of the most important points in handling safety, is given prime consideration on most available equipment. This has been accomplished in part by re-design of the upright construction, improved hoist designs, dual controls, proper positioning of the operator, etc.

Safety control brakes are an important feature of today's industrial trucks. Brakes have now been im-

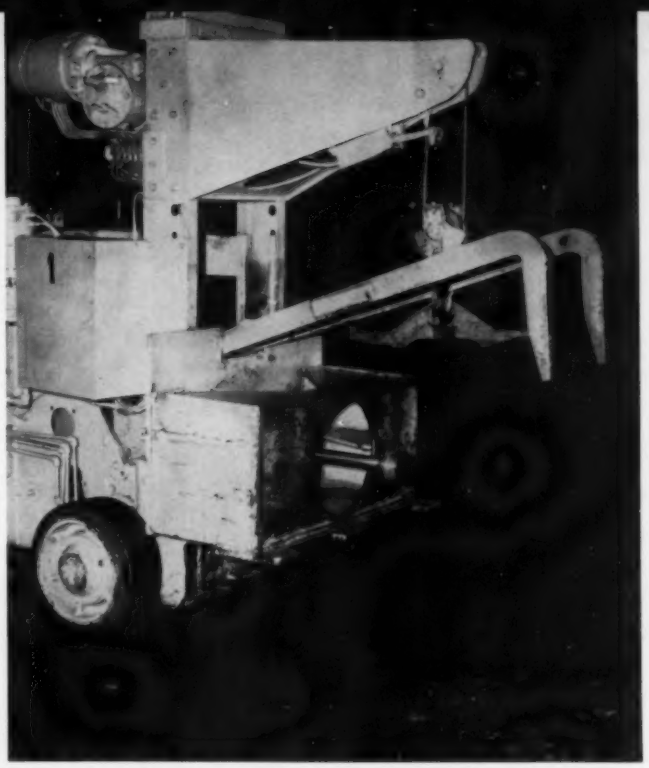

Figure 7 — The truck attachment shown is a bearing extractor, which incorporates a lift, hoist, travel, and pusher motion into a compact unit that does a unique job.

proved to a point where trucks are now available with three separate braking systems. Hydraulic wheel brakes, an emergency brake on the motor or gear shaft, plus dynamic or plugging electrical braking, all provide positive means for stopping the large masses of moving equipment with the greatest safety; and at least two, if not all three systems can be found on any truck.

Hydraulic-, mechanical-, or booster-type power steering, which is also available on most trucks with over 6,000-lb capacities, and which is standard on the larger capacity ram and fork trucks, reduced another operator's hazard.

Controlled acceleration of the travel speed, no-plug control or controlled plugging, shockless steering, safety flow control valves in the hydraulic system, and many other similar features found on many of today's trucks, also contribute much to the general advance of safety engineering.

Closely alined to the subject of safety in truck operation is the inspection and maintenance of such equipment. One cannot stress too strongly the importance of expertly trained truck operators, the establishment of a

Figure 8 — A special boom is mounted on a conventional fork truck to handle loads of sheet steel.

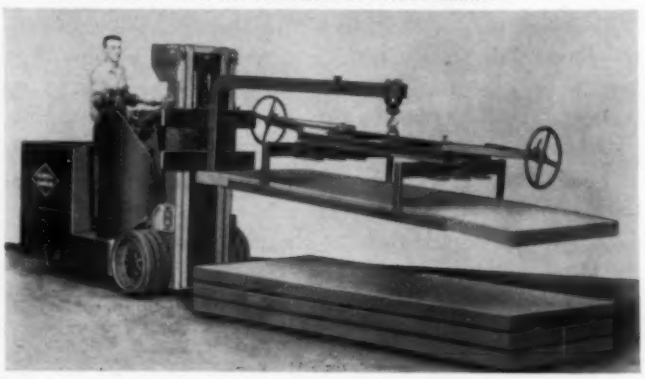

Figure 9 — A special design machine for reel and coil handling.

regular and thorough inspection program, and the instruction of maintenance personnel on the vital responsibilities of proper maintenance.

Good operators and safe handling of material depends largely on the condition of the equipment itself. These factors should be checked as a means of reducing accidents and increasing production. Equipment in poor condition encourages improper and often unsafe handling practices. The best safety features built into a piece of equipment becomes useless through improper maintenance.

The subject of maintenance is one that is receiving increased consideration in nearly every industry today. Nevertheless, the apparent lack of an effective system in actual practice has created problems for industrial truck manufacturers.

Let us consider a few. We all recognize that an effective preventive maintenance program will go a long way toward keeping equipment in operation with a minimum of downtime. This however, is considerably easier where trucks are used for example in a warehouse, as opposed to the severe operating conditions in a steel mill.

In many mills, where equipment is required on a round-the-clock basis, and in many cases where all inspection and repair must be done during production hours, this equipment cannot receive the proper attention that is so vital.

Truck manufacturers must, therefore, take this fact into consideration, and trucks now used in the steel industry reflect much of the effort that has been expended in this direction.

In an effort to minimize both breakdowns and repairs, generous safety factors have been incorporated in every phase of design. All mechanical as well as electrical parts used on such equipment are selected for their generous ore load capacity to assure a minimum of required maintenance.

Since almost all preventive maintenance and repair

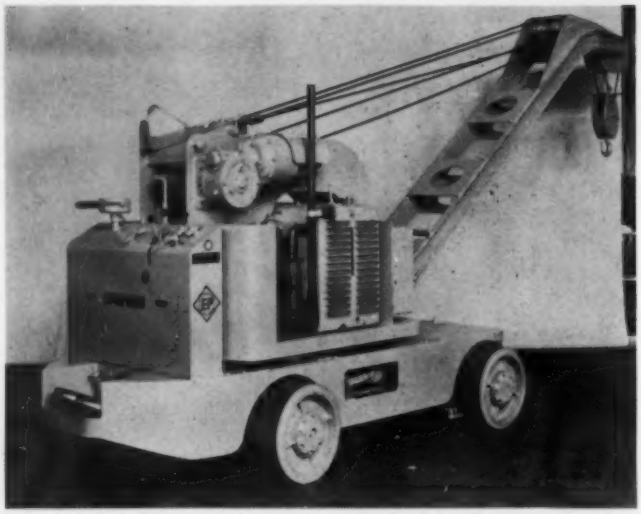

Figure 10 — The mobile crane is found in most every steel mill today.

must be done at the expense of productive time, it is essential that all equipment be designed for ease of access of parts. Along this line, many mills now practice the method of stocking spare major drive and hoist assemblies so that damaged units can be replaced in the truck as a complete unit, thereby expediting the truck's return to service. The damaged unit is then repaired on the bench at a more convenient time, then returned to stock; accordingly, truck downtime is minimized.

This practice, which has become more widespread in recent years, has led some truck manufacturers to design their whole truck around a unit assembly basis. The drive axle, trail axle, hoist unit, and similar assemblies are packaged units that can readily be removed from the truck in what is often only minutes of time. While this design feature is particularly important to the fleet user in enabling him to stock spare assemblies, it also aids the smaller user who finds it more convenient as well as more expedient to repair a unit out of the truck rather than in the vehicle. Special tools, often required to properly service a unit within the truck because of limited clearance, are likewise eliminated.

In a like endeavor to minimize preventive maintenance time, centralized or one-shot lubrication systems are being installed on an increasing number of fork and ram trucks.

We have seen that both safety and maintenance are closely related to the production problem of a mill, and it is this latter factor that probably gives the truck manufacturer his biggest single headache. What is done to a truck at times under the guise of production requirements can never be fully evaluated.

For example, a perfectly sane person who operates an industrial truck under an incentive program, may throw caution and common sense to the winds. It is under such circumstances that many of the safety features originally built into the truck, at least for a time, are pushed aside in an effort to set a new production record or win an incentive pay allowance.

No matter how much of an overload factor is put into a truck, there is always the point where this factor is pushed to the limit or even exceeded, and it is this human element that constitutes such a serious problem to the industrial truck designer.

Several years ago, a well known automobile manufacturer purchased a 30,000-lb die handling truck of the platform type. Sometime after the truck was put into service, a freight car loaded with urgently needed steel was shunted into the company's yard. During this process, the car was partially derailed, causing a possible delay of several hours. This prospect was so serious that the production manager went to investigate, and after sizing up the situation, ordered the new truck to be maneuvered into position under the drawhead on the end of the derailed car.

The industrial truck lifted the end of the car enough to place it back on the rails, thereby saving a shutdown, the cost of which would have been more than the truck.

Needless to say, this incident is not an example of what to do or expect of such equipment. However, things nearly as bad are attempted every day unbeknown to plant supervisors, where the risk of truck damage far exceeds costwise the benefits of the task being performed. Often truck parts which are damaged unknowingly, later fail when least expected, often at a critical time.

Every truck owner is confronted with conditions peculiar to his plant or warehouse layout which cannot be greatly changed to favor truck operations. And of course, steel mills are no exception.

In the past ten and 15 years, we have seen the sizes of coils rolled being increased considerably, necessitating larger capacity trucks. The aisle space and areas for maneuverability have, to a large extent, remained the same. This means that the extreme dimensions of the truck must be held within restricted limits while the capacity requirement increases. In addition, the greater load weights resulted in increased concentrated axle loadings which in turn required larger as well as a greater number of drive and trail tires to more effectively distribute the load over the floor area.

Also, since the available operating space factor often limits the number of trucks which can be operated with safety in a given area, increased handling requirements have prompted increased requirements for travel and hoist speeds as well as for capacity loading.

These new requirements played no small part in influencing the general design features of the steel mill truck of today. The introduction of the hydraulic lift with its resultant fewer operating units and simplification of controls, has brought about a more compact machine for handling of increasingly heavier loads.

The improved power steering system, fifth-wheel drive, caster-type steering, dual drive units, and hydraulic wheel brakes, are but a few of the developments that have enabled these handling giants to meet in large, the challenge of this industry.

One cannot put too much emphasis on the necessity of maintaining a well organized material handling system in operation. Such a system is predicated on equipment that affords the greatest production time with a minimum of down-time or out-of-service factor.

The industrial truck industry feels proud of the contribution made to the general material handling movement, and in particular, to the challenge put forth by the steel industry.

We also offer our fullest cooperation in designing and building the type of equipment that reflects the progressive requirements peculiar to this industry.

Recent Developments in European Steel Practices

By H. B. EMERICK, Director — Technical Services, Jones and Laughlin Steel Corp., Pittsburgh, Pa.

. . . . important developments in European steelmaking practices emphasize enriched air blast for a bottom-blown basic converter; pre-refining of iron in the ladle; enriched air for low shaft reduction furnaces; and oxygen top blowing in basic converters . . . . this latter item may easily become one of the important steelmaking processes . . . .

▲ IN the course of a recent business trip abroad an opportunity was presented to observe at close range several significant post-war steel industry developments in Western Europe. The primary objective of the trip was to investigate the new oxygen converter steelmaking process developed recently in Austria. A secondary objective was to evaluate development work directed toward a revolutionary design of low-shaft smelting furnace. Other process developments of technical interest included: (1) new methods for desiliconizing and desulphurizing blast furnace hot metal; (2) progress in the utilization of nitrogen-free gas mixtures for refining molten iron in basic bessemer converters.

A comparison of 1954 steel ingot production in Western European countries is given in Table I.

TABLE I

Country	1954 Production (Net Tons)
Great Britain	20,725,000
West Germany	19,100,000
France	11,335,000
Belgium	5,385,000
Luxembourg	3,070,000
Austria	1,755,000
Netherlands	1,010,000

The iron ores mined in Great Britain and Germany (as well as the much richer ores of north Sweden used to improve the burden) are relatively high in phosphorus. Consequently, in these countries the steel industry is burdened with all the metallurgical problems surrounding the oxidation and removal of large amounts of phosphorus.

BASIC BESSEMER PROCESS

The Thomas converter refines pig iron into steel by blowing compressed air through tuyeres in the bottom of a basic-lined vessel. It is especially well suited to deal with the problems presented by hot metal which is unusually high in phosphorus. While basic converters are operated by only two plants in Great Britain, Thomas steel accounts for 40 per cent of German production, 85 per cent of Belgian production and practically all of Luxembourg's. The process has become increasingly important since the development of economical tonnage oxygen plants because the use of oxygen offers new possibilities for improving both production rate and quality of converter steel.

The basic converters used in Europe have capacities ranging from 17 to 65 tons of steel. The vessel lining is basic brick or rammed dolomite and has a life of 250 to 650 blows. A monolithic bottom is constructed of rammed dolomite mixed with 6 to 8 per cent tar. The dolomite contains 35 to 40 per cent magnesia, 55 to 60 per cent lime, and low silica. The refractory mixture is rammed in a stamping machine in successive 6-in. layers, with ½-in. needles being pushed through the stamped mass to form the more than 200 tuyere holes. On completion the needles are withdrawn, the tuyere holes are protected by driving in wooden dowel rods and the bottom is fired at 1380 F over a 6-day heating and cooling cycle. Bottom life generally ranges from 50 to 80 heats.

In normal practice a converter charge consists of molten pig iron, lime for fluxing silica and P_2O_5, plus scrap, ore or limestone. The amount of scrap or limestone depends on the oxygen concentration in the blast, the grade of steel to be produced, and also upon economic conditions. With atmospheric air the quantity of scrap used is 3 to 9 per cent of the liquid iron charged. With enriched air the quantity of heat developed during blowing is greater and this provides means for melting additional scrap.

With an oxygen concentration of 30 per cent in the blast, the total amount of scrap charged may be increased to 15 or even 20 per cent; nitrogen content in the finished steel will be reduced about 20 per cent and production rate increased in the same degree. When scrap is expensive, iron ore may be used. The equivalent factor in respect to thermal balance between scrap and ore is around 2 to 2.8, which means that one pound of ore can be charged to the converter instead of 2 to 2.8 pounds of scrap.

If extremely low nitrogen content is desired in the steel, other methods must be used, such as blowing with mixtures of oxygen and nitrogen-free gases. Pure oxygen cannot be used in a bottom-blown converter because the refractories in the tuyere zone would not stand up. Therefore, some other inert gas must be substituted for the nitrogen component of ordinary air. Superheated steam is the most economical gas for dilution. A suitable ratio is 60 per cent oxygen (95 per cent pure) and 40 per cent steam. The oxygen consumption using this method is approximately 1500/2000 cu ft per ton of steel produced compared with under 1000 cu ft per ton with oxygen-enriched air blowing. A 60-40 oxygen-steam mixture is approximately thermally equivalent to air, hence no extra scrap can be consumed. With such a mixture the influence of temperature on nitrogen absorption disappears completely, making it possible to produce steel with both a low nitrogen and a low phosphorus concentration—even though temperature of the blown metal may be extremely high.

A whole range of metallurgical possibilities is therefore offered at the present time by the Thomas steelmaking process. In brief these processes are as follows:

1. Conventional basic bessemer process giving a nitrogen content generally over 0.010 per cent.
2. Ore, mill scale or limestone additions and blowing with ordinary air, affording nitrogen contents of 0.007 to 0.010 per cent.
3. Ore, mill scale or limestone additions and use of oxygen-enriched air, resulting in nitrogen contents of 0.005 to 0.007 per cent.
4. Use of mixtures of oxygen with steam, affording nitrogen contents below 0.004 per cent.

BASIC OPEN HEARTH PROCESS

At the same time, European steelmakers have an obvious interest in the Siemens-Martin or basic open hearth process since it is preponderant in Great Britain and is responsible for 60 per cent of Germany's production, 30 per cent of France's and 15 per cent of Belgium's.

European research into open hearth steelmaking has taken two principal lines: (1) a physico-chemical approach to desulphurization reactions in refining (their fuel oil contains up to 3 per cent sulphur!); (2) systematic studies of combustion and heat transfer phenomena.

The addition of burner oxygen in the open hearth combustion system continues to receive attention. A fair amount of pilot-scale development work has been done in Germany where furnace design has been changed drastically in order to more efficiently utilize combustion oxygen. German engineers correctly point out that the quantity of waste gases is greatly reduced when burning oxygen. Hence they see little need for the customary wide port-end openings and downtakes for discharging combustion gases. Furthermore, it seems to them highly probable that it does not pay to recuperate and utilize for preheat the small quantity of waste gases available when burning oxygen, so they would eliminate the regenerators entirely. If the furnace no longer requires regenerators why, they ask, should it retain its classic rectangular shape — a shape which is characterized by a high degree of heat radiation. Ultimately, the Germans visualize the oxygen-fired, open hearth steelmaking furnace as somewhat similar in design to the modern electric furnace, with removable roof and tiltable construction. Discussion as to the best arrangement of burners and off-takes is still going on.

PRE-REFINING — DESILICONIZATION WITH OXYGEN

Throughout Europe, an increasing amount of technical effort is being directed toward development of efficient means for pre-refining iron prior to charging the hot metal into open hearths or converters. Essentially this covers methods for externally desiliconizing and desulphurizing blast furnace product.

It has been a matter of experience when bottom blowing high-silicon iron with oxygen-enriched air that metal frequently is ejected from the converter during the early, low-temperature stage of the blow. To overcome this difficulty, various methods have been developed to desiliconize hot metal in the iron ladle with low-pressure oxygen, and thus produce a superheated iron which can be successfully bottom-blown with oxygen-enriched air at full blast throughout the entire refining period. The net result is an attractive further reduction in blowing time and still lower nitrogen content in the finished steel. In addition, converter yield is increased about one per cent and lime consumption reduced about 30 lb per ton of iron because of the lower silicon content.

At one plant in the Ruhr district, 80 per cent of all iron produced is pre-blown with oxygen before going to the mixers. There are six blowing stations under one roof, each with a water-cooled cast iron hood rigged so it can be lowered flush against the rim of the iron ladle. Projecting laterally through a hole in the side of the hood is a short water-cooled, copper-tipped oxygen lance tilted downward at a 30 degree angle so that the tip is about 6 to 12 in. below the surface of the metal. Oxygen of 73 per cent purity is blown through the lance orifice for about 30 minutes at a relatively low pressure of 2.5 atmospheres. The effect of this treatment is to reduce the silicon content about 0.25 per cent and the manganese about 0.60 per cent, with a 100 to 150 F rise in iron temperature. The slag formed is foamy but relatively inert since no vigorous boiling action takes place. The life of the ladles is not affected to any great extent by the use of oxygen. Only the two upper courses of brickwork which come into contact with the slag require more frequent repairs than normally is the case.

Parallel work is in progress in France. There the most successful system devised uses a high-pressure gaseous oxygen jet of great penetrating power fed vertically through a refractory-coated, non-immersed copper lance. This procedure is used to treat the entire hot metal production in one French steel plant whenever the silicon content is above 0.50 per cent.

A major problem associated with oxygen pre-blowing is the collecting and cleaning of the dense oxide fumes which are generated in the process.

DESULPHURIZATION OF IRON WITH SOLID LIME

The most interesting new development in this field is the Kalling-Domnarvet process where molten iron is treated in a rotating cylindrical furnace with finely ground burnt lime. Hot metal is charged and withdrawn through end openings which are sealed during rotation so that strongly reducing conditions are main-

tained inside the furnace. Rotating the furnace at about 30 rpm insures intimate contact of lime and liquid metal so that a high order of chemical efficiency is achieved. Since no molten slag is formed during the process the furnace may be lined with ordinary fireclay brick.

Iron containing up to 0.100 per cent sulphur can be treated with one per cent powdered lime, and after 15 to 30 minutes in the rotating furnace, the sulphur is reduced to 0.010 per cent or less. The cost of such an operation is said to be about 50 cents a ton.

The largest furnace built so far holds 30 tons of iron. A 60-ton furnace is now under construction in Sweden. This installation will desulphurize 300,000 to 400,000 tons of iron per year. There seems to be no reason why the capacity of such furnaces could not be increased to at least 100 tons.

LOW-SHAFT BLAST FURNACES

Economic incentives have generated intense interest in Europe in developing a method for smelting iron using inferior ores and low-grade fuels which are unsuited by size and quality for use in the standard blast furnace, at least without extensive and costly burden preparation. Theoretically, a low-shaft furnace should be able to utilize fuels with relatively low resistance to crushing. However, to operate such a furnace with thermal efficiency approaching that of the conventional blast furnace, requires top gas temperatures as low as those in the standard furnace. This necessitates a very steep temperature gradient through the furnace which probably can be obtained best by the use of oxygen-enriched blast.

In Central Germany, behind the Iron Curtain, attempts are being made to smelt pig iron from locally mined ores poor in Fe units and from coke produced from low-grade lignite. According to available information, 20 small blast furnaces of rectangular cross-section will be erected. Several of these furnaces are said to be in operation already, smelting foundry pig.

In West Germany there are two experimental low-shaft blast furnace installations worthy of mention. At Oberhausen, a circular furnace 23.8 ft high and 7.9 ft diameter in the hearth has produced approximately 50 tons of 45 per cent ferromanganese per day from low-grade African and Indian ores. The furnace has 6 tuyeres of 3-in. diam. When normal wind is blown, the coke rate is 4520 lb per net ton of iron. With enriched air (30.5 per cent oxygen), the coke consumption decreases to 3510 lb per ton. A detailed cost study has convinced the Oberhausen management that production of ferromanganese and ferrosilicon in a low-shaft furnace with oxygen-enriched blast is an economical proposition. The reverse is true when steelmaking iron is produced.

The Demag-Humboldt combine at Cologne, Germany has been working for several years on a process for smelting coal-ore briquets in a low-shaft furnace producing pig iron and ferroalloys. Small briquets are formed under 3500 psi pressure, using 6 per cent coal tar pitch as a binder, with about 30 per cent dried ore fines and the balance crude high-volatile non-coking coal. Due to the limited height of the charge column in the furnace, only moderate requirements are placed on the strength of the briquets.

The experimental furnace is in the shape of a near-rectangle with two parallel straight sides connected by two curved ends. Hearth area is 17.2 sq ft. There are four tuyeres of 4-in. diameter. Distance from tuyere plane to stockline is 10.2 ft. The furnace is lined with carbon brick to the mantle and finished off with fire brick to the top. This process has not as yet approached a stage that would justify considering it for use on a commercial scale.

The newest low-shaft blast furnace went into operation at Liege, Belgium about two years ago. It is of semi-oval cross section, with a major axis of 9 ft-7 in. and a minor axis of 3 ft-11 in. Side walls are vertical with a height of 16.5 ft. Hearth area at tuyere level is 32 sq ft. There are eight tuyeres of 2.4 in. diam. Charging takes place through two bell-bottomed closed hoppers, designed to be sufficiently tight so that the furnace can be operated at high top pressure if desired. The furnace is lined with low alkali, high alumina clay bricks.

This experimental furnace produced more than 7,000 tons of iron during its first year of operation, using low-grade minette ores containing only 26 to 34 per cent iron. The coke rate averaged about 3200 lb per ton of iron. Despite the heavy slag volume of about 2000 lb per ton, sulphur content in the metal generally exceeded 0.100 per cent.

It is still too early to properly appraise the practical significance of this work, but it seems unlikely that any of these low-shaft furnaces will seriously challenge the position of the standard coke blast furnace in this country within the foreseeable future.

OXYGEN STEELMAKING PROCESS

The oxygen converter process, which is evolutionary in character rather than revolutionary, combines certain advantages offered by both the basic open hearth and the basic converter processes, and at the same time eliminates many of their respective deficiencies. In this process, molten blast furnace iron is refined to steel in a basic-lined, solid (tuyereless) bottom vessel by directing a jet of nearly pure oxygen vertically, at high velocity, onto the surface of the hot metal bath. The bath absorbs the gas almost completely, as the actual oxygen consumption is very close to the theoretical requirement. Oxygen of 98 per cent minimum purity is discharged through a retractable water-cooled, copper-tipped lance. The resulting product — low in phosphorus, sulphur and nitrogen contents – is comparable in quality with basic open hearth steel, yet the production rate is on a level with the conventional bessemer converter processes. The capital investment and unit conversion costs are much lower than for an open hearth shop of equal capacity. Actually, the cost of installation is no higher than for converter plants of traditional design since the additional cost for a tonnage oxygen production plant is offset by the elimination of auxiliary equipment such as turbo-blowers, bottom house and bottom charging facilities. With each ton of steel requiring approximately 2,000 cu ft of oxygen for refining, the cost of oxygen becomes economically feasible with a plant producing 80 to 100 tons of high-purity oxygen per day, equivalent to steel production of 200,000 to 300,000 tons per year.

Raw Materials—A major advantage of the oxygen converter process is its remarkable flexibility in handling

a wide range of raw materials. The process can be operated on any kind of hot metal that can be used in the open hearth furnace and, in addition, it will accommodate iron of a type which is normally unsuitable either for the open hearth or the conventional converter processes.

The new oxygen steelmaking plants at Linz and Donawitz in Austria operate on blast furnace metal which covers a range from 0.2 to 1.5 per cent silicon, from 1.5 to 3.0 per cent manganese, and up to 0.25 per cent phosphorus. Depending on the level of heat-producing elements in the iron, the normal range of scrap additions is 12 to 25 per cent of the gross metallic charge. This is much higher than heretofore possible in bottom-blown converter practice.

Refractories—The converter itself may be either eccentric or concentric in design. A permanent lining next to the shell plates consists of a single course of burned magnesite brick. On top of this is a rammed layer of tar-bonded dolomitic magnesite which is renewed each time the vessel is relined. The inner or working lining is a very thick, unfired brick pressed from a mixture of sintered magnesite and coal tar pitch. The total lining thickness is approximately 20 to 24 in.

The solid bottom of the vessel, which may be either integral or detachable, is somewhat hemispherical in contour and is built up much like a basic open hearth bottom. There is a single course of clay brick on the shell, then two horizontal courses of magnesite brick, a soldier course of magnesite brick and, finally, a rammed layer of burned magnesite to form the working surface. The bottom is about 26 in. thick overall. Normally it remains in good condition indefinitely, while the body lining fails by even wear on the side walls in the reaction zone. The lining must be patched or replaced after blowing approximately 250 heats, or roughly after one week of operations.

Method of Operation—The blowing equipment consists of a tubular water-cooled, retractable jet device kept in a vertical position above the center line of the vessel. At the top of the lance, armored rubber hoses are connected to a pressure-regulated oxygen source and to a supply of recirculated cooling water. After charging the vessel with scrap and hot metal, the oxygen jet is lowered to a position above the surface of the bath. This distance is fixed by experiment and certain known variables. Oxygen issues from the jet nozzle under pressures which may be regulated over a fairly wide range, but are usually held between 100 and 150 psi. Impinging on the surface of the liquid bath the oxygen instantaneously starts reactions leading to the formation of iron oxide, part of which diffuses rapidly through the bath. Carbon monoxide is immediately evolved which gives rise to a vigorous boiling action and accelerates the refining reactions.

Slag-forming fluxes, chiefly burned lime, are added during the blow through inclined chutes built into the sides of a brick-lined smoke hood that covers the vessel. No flame is visible outside the mill buildings. A dense cloud of reddish-brown fumes is emitted from the converter. The dust contained in the gases is mainly iron oxide of extremely fine particle size. An efficient system for collecting and cleaning exhaust gases is essential.

All heats are blown down to 0.05 or 0.06 per cent carbon and recarburized in the ladle if necessary. The endpoint normally occurs after 18 to 23 minutes blowing time and is signalled by the collapse of the carbon flame.

Gross yield, from metal charged to liquid steel, is approximately 90 per cent.

Product Performance—Since the oxygen steelmaking process employs a refining agent whose nitrogen content is practically nil, a steel is produced which is distinguished by its exceptionally low nitrogen content — generally 0.004 per cent or lower and well within the expected range for open hearth steel. Eighty per cent of the heats finish below 0.030 per cent sulphur and 0.025 per cent phosphorus. The material exhibits good cold forming properties and good weldability. In a wide variety of applications including wire products, tin plate, hot and cold rolled sheets, plates and bar products, the material has held its own against basic open hearth steel of similar carbon content.

Outlook—Considering that pilot scale experiments started less than seven years ago, the oxygen steelmaking process has experienced phenomenally rapid development to its present established position as a mature commercial process. In 1953 the process accounted for 330,000 tons of steel production in Austria alone, or 22 per cent of that country's output. In 1954 this was expanded to 450,000 tons. It is estimated that world production will be well over 1,000,000 tons of oxygen converter steel in 1955.

Any steel company planning a carbon steel ingot expansion program, or seeking a way to improve upon existing converter steelmaking methods, cannot afford to overlook the oxygen steelmaking process.

SUMMARY

The most significant and far-reaching post-war development in European steelmaking practice stems from the discovery and application of new means for producing tonnage oxygen at low cost by liquefaction of air. Much has been accomplished in Europe toward developing new and efficient methods for utilizing pure oxygen in a variety of metallurgical processes. The most important of these in the field of ferrous metallurgy are: (1) enriched air blast for bottom-blown basic bessemer converters; (2) pre-refining of iron in the hot metal ladle — applicable to either basic open hearth or basic bessemer operations; (3) enriched air blast for low shaft reduction furnaces; (4) oxygen top blowing in solid bottom basic converters. The last of these developments seems destined to command worldwide attention as it gives every promise of placing the pneumatic process of steelmaking in an entirely new perspective.

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DISCUSSION

PRESENTED BY

H. F. LESSO, Metallurgist — Open Hearth Control, Great Lakes Steel Corp., Ecorse, Detroit, Mich.

H. B. EMERICK, Director — Technical Services, Jones and Laughlin Steel Corp., Pittsburgh, Pa.

J. A. SHIMMIN, Vice President in Charge of Operations, Rotary Electric Steel Co., Detroit, Mich.

PAUL E. LINDBERG, JR., Superintendent Hot Metal Div., McLouth Steel Corp., Trenton, Mich.

ROBERT SERGESON, Chief Metallurgical Engineer, Rotary Electric Steel Co., Detroit, Mich.

WARREN E. HART, Superintendent Electric Furnace Building, Ford Motor Co., Rouge, Dearborn, Mich.

H. F. Lesso: What were the relative ferrous oxide levels found in the oxygen converter steel?

H. B. Emerick: I can answer that with a few facts. I brought back some samples and had them analyzed for oxygen content. Samples representative of the operation at Linz, Austria, checked 0.0052 per cent oxygen; presumably this was semi-killed steel. Samples of rimmed steel from the Donawitz plant checked 0.013 and 0.019 per cent oxygen. These values are no higher than might be expected in basic open hearth steel of comparable carbon content and similar deoxidation practice.

H. F. Lesso: Did you also observe the rimming performance of metal in the ingot molds?

H. B. Emerick: Yes, most of the steel produced in Austria is of that variety and the ingots rim quite normally. At one plant they were bottom pouring, and at another plant some top casting was being done. In no case did I see any evidence that this product was deficient as far as rimming quality is concerned.

J. A. Shimmin: What is the difference in the operational cost of an oxygen plant using 95 per cent purity oxygen instead of 98 plus? There is quite a difference in the cost of oxygen in those ranges.

H. B. Emerick: Are you referring to the cost of operating the air separation plant or the fuel cost in the converter operation?

J. A. Shimmin: Fuel cost in the converter and the effect in the converter of the lower purity oxygen.

H. B. Emerick: To answer your last question first: the evidence seems to indicate that if you drop below 98 per cent purity in the oxygen gas, you immediately notice an increase in nitrogen absorption. It is possible that this is associated with the extremely high pressures and temperatures which are reached in this process. Under these conditions the solubility of nitrogen is greatly increased so that any contamination of the refining gas will be immediately reflected in increased nitrogen pickup.

The savings in the cost of operating an oxygen generating plant, say, of 100 tons per day capacity, might be of the order of a dollar per ton of oxygen if the gas purity could be accepted at the lower level of 95 per cent. In addition to the lower operating cost, initial capital investment would be somewhat lower also.

Concerning relative fuel cost for the refining operation as between these two levels of oxygen purity, I doubt if the differential would amount to more than 10 per cent of the cost of oxygen gas per ton of steel. This is somewhere in the range of 60 to 90 cents per ton of steel. I would say you could expect only a relatively small improvement in the oxygen cost per ton of steel.

Paul E. Lindberg, Jr.: I think that is right. We have not used our maximum oxygen. We have a 160-ton oxygen plant, but in a usage of about 110 ton of oxygen, we feel that our cost per ton of oxygen will be in the order of 8 to 10 dollars a ton. So based on Mr. Emerick's consumption figures per ton of steel, it would be some place in the order of 60 to 75 cents per ton of ingots. We have noticed that if we are under 99 per cent purity you have a slightly higher nitrogen than you do at a 99.5.

At our maximum oxygen purity of 99.7, we have had nitrogens down to 0.0014 per cent. The higher the purity of oxygen, apparently the lower the nitrogen.

Robert Sergeson: Are they making any fine grain steels, and do they find that they have to add the same amount of aluminum to make the fine grain as in the regular open hearths?

H. B. Emerick: They find the aluminum requirement to be exactly the same as it would be in open hearth steel of comparable carbon content. The Austrians have not made a great deal of the non-aging type of steels, but some have been made.

Warren E. Hart: Am I right in assuming that this method would lend itself favorably to the production of alloy steel and eventually to the stainless type?

H. B. Emerick: For the simpler alloys, expecially the low-carbon carburizing types where the alloy content could be obtained by ladle additions (perhaps of exothermic alloys) there would be a definite possibility of using the process. At present I see no possibility of producing stainless and high-alloy types.

H. F. Lesso: What major changes would have to be brought about should the oxygen converter be increased in size to 100 or 125 tons?

H. B. Emerick: This would present some major engineering problems. I believe a most important consideration would be to control the depth of bath so that it didn't increase beyond 42 to 45 in. Considerable thought has been given to adapting this principle to some shape of vessel entirely different from a converter, something that would look like a modern arc furnace or even a basic open hearth furnace where larger heat size could be obtained. A tap hole would be placed in such a vessel. Downtime would be minimized by increasing the capacity of the refining vessel two or three times that which can be achieved in a conventional converter. If these larger capacities are reached, I think they will probably require some basic change in the shape of the refining vessel; it will no longer look like a converter.

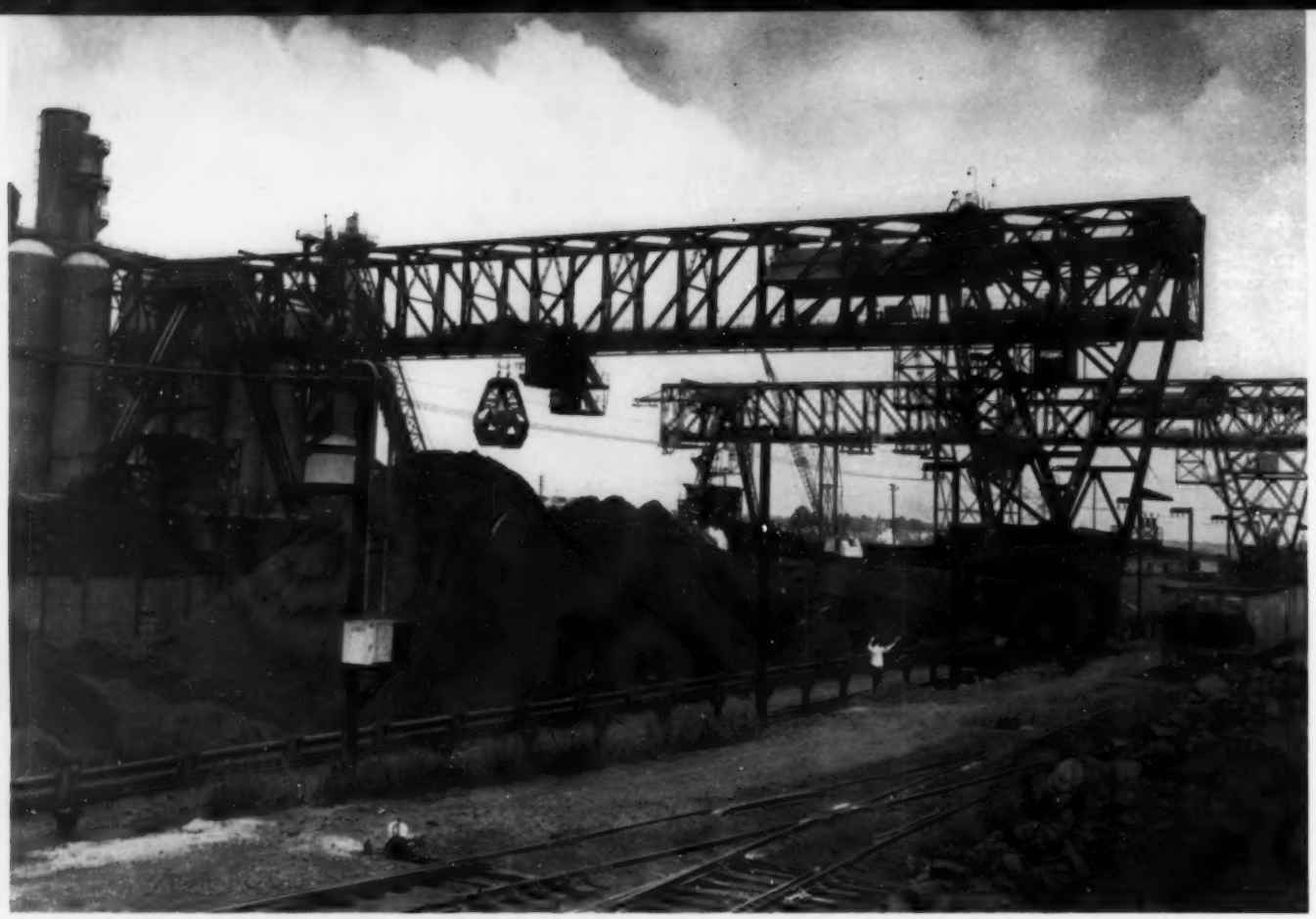


Figure 1 — This bridge uses a bucket with rated capacity of over 20 tons, which is hoisted at approximately 250 fpm. The collectors for the high voltage a-c power are the overhead, suspended conductor type. An interesting feature of the bridge shown here is that the machinery house is located on the sill of the pier leg, a feature made possible because no ore handling operations take place out over the motor-generator set house.

ELECTRICAL ASPECTS of Adjustable Voltage Ore Bridges

By E. H. GAUTIER, Assistant Manager, Industrial Engineering Dept., Elliott Co., Pittsburgh, Pa.

▲ THE application of d-c adjustable voltage to the main drives of ore bridges has been advanced in recent years for several reasons. It will be of interest to cover briefly the reasons for that trend then go on to examine some of the electrical features of an adjustable voltage ore bridge which are unique to the application.

At the end of World War II there was a general expansion and modernization movement in the steel industry. In most of the steel mills this was to result in an appreciable increase in the steel tonnage capacity which meant a proportionate increase in the mill requirements for ore storage, stocking speed, and furnace feeding capacity. This in turn called for an increase in the tons-per-hour handling capacity of the ore yard bridges over what was currently available.

At some mills, the addition of a new ore bridge to an existing ore yard operating with constant potential bridges would have meant the overloading of existing constant potential d-c generating facilities or the installation of new d-c generating capacity to accommodate the new bridge.

. . . . adjustable voltage application on ore bridges results in greater bridge capacity because of higher acceleration, higher hoist and trolley speeds, and greater bucket capacity . . . . better control is made available to the operator . . . . because of smoother operation less maintenance is required . . . .

The required increases in stocking speed and furnace feeding capacity were not compatible with a strong desire on the part of the mills to continue the use of the AISE standardized 600 series mill motors as main drive motors on the ore bridges. In order to meet the

required tonnages, the bridges would have to use larger buckets (up to and above 20 tons rated capacity) handled at higher speeds (up to and above 300 fpm), and having greater rates of trolley acceleration and trolley speed (up to and above 1200 fpm). These requirements pointed to the need for motors of greater capacity than the 200-hp continuous rating of the 618 mill motor operated at 230 volts.

The adjustable voltage bridge has provided a satisfactory answer to these problems where they appeared in sufficient number and in sufficient strength to justify the cost of an adjustable voltage ore bridge.

Where the need existed to increase constant potential d-c generating capacity to accommodate a new bridge, the adjustable voltage bridge provided a ready answer because power is brought directly to the bridge in the form of high voltage alternating current which is usually in relatively plentiful supply. When the cost of installing a new constant potential generating capacity and the expansion of a constant potential distribution system are considered a part of the cost of a new constant potential bridge, the cost of an adjustable voltage bridge is easily justified.

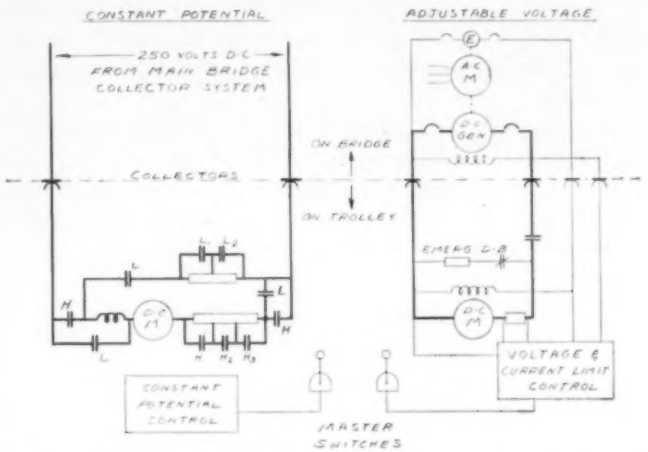


Figure 2 — Two typical hoist control systems are shown by schematic diagram.

The distribution of the high voltage a-c power along an ore yard of great length poses a much less severe voltage regulation problem than a 250 volt d-c distribution system would. There are several installations currently operating in this country which have proven the effectiveness of such high-voltage a-c power distribution.

One of the strongest reasons for the promotion of the adjustable voltage bridge is that it has permitted use of the 600 series mill motors on bridges which provide greater capacity than would be possible with the same number and size motors on a constant potential driven bridge. The increased capacity comes from operation of the shunt wound mill motors at greater than rated armature voltage, thereby increasing the motor speed and output shaft horsepower. The resultant increase in the capacity of the hoist drive, for instance, at a negligible increase in the weight of the hoist machinery, results in lighter trolley and overall bridge structure weight.

The electrical features of an adjustable voltage ore bridge drive are considerably different from a conventional constant potential drive. Figure 2 shows, for comparison purposes, the main power and control circuits of a constant potential hoist drive and an adjustable voltage hoist drive.

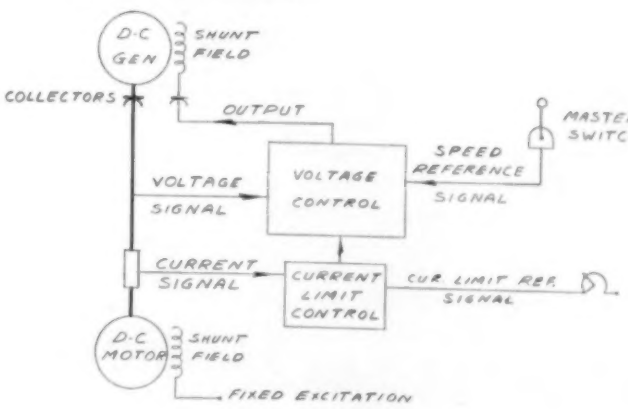
The constant potential system requires only two power collectors between bridge and trolley for all trolley drives and trolley auxiliary loads such as lights and heating. The adjustable voltage system requires a greater number of collectors as this figure implies. (Figure 5 gives a more comprehensive picture of the collector requirements of an adjustable voltage bridge).

The schematic shows that the adjustable voltage electrical drive components required on the trolley are the d-c drive motor, an armature circuit contactor, a light duty emergency dynamic braking circuit, and the voltage and current limit control. The output of the voltage and current limit control is the shunt field of the drive generator on the bridge and it is transmitted to the generator field over a control collector. The constant potential exciter supplies control and auxiliary power to the trolley. On the trolley this constant potential d-c power is used for motor field and shunt brake excitation, and auxiliary power requirements such as lighting and heat. The contactors shown in the adjustable voltage armature circuit remains closed during all normal duty cycle functions, and the dynamic braking circuit shown is a light duty circuit because it is for emergency use only.

The relatively large number of contactors required for the constant potential drive is evident. The constant potential contactors are operated two or more times during each duty cycle, making their maintenance a factor which must be lived with at all times. In addition to the contactor requirements on the trolley, the constant potential drive requires a number of resistors which must be heavy duty units. Conversely, the adjustable voltage resistors required are low in number and weight. The emergency dynamic braking resistor is small and intermittently rated, and all other resistors are light, control resistors. This means the possibility of realizing a control weight saving on the trolley when using adjustable voltage on the main drives. A lighter trolley means lighter construction of the entire bridge with resultant savings on the cost of the bridge structure.

The constant potential control shown in block form consists of the required control relays and contactors which are of basic mill construction. The voltage and

Figure 3 — A typical adjustable voltage regulator is shown as it would be applied on the hold, close or trolley drive of the ore bridge.



current limit control which is a part of the adjustable voltage drive is shown in very basic form in Figure 2. Figure 3 will amplify its functions.

Figure 3 shows a typical adjustable voltage regulator as it would be applied on the hold, close or trolley drive of an ore bridge. The shunt-wound mill motor with fixed field excitation is energized directly by a shunt-wound generator. The mill motor, having relatively flat speed torque characteristic typical of a shunt-wound d-c motor, follows closely in speed the voltage of the generator.

The voltage control output provides the excitation of the generator shunt field. This control has three major signals fed into it. They are the speed reference, the voltage signal and the output of the current limit control. The speed reference signal is a voltage proportional to the operator's master switch position and of a polarity corresponding to the direction of master switch movement, and the voltage signal is a voltage proportional to the applied motor armature voltage.

The current limit control output is of an "off-on" nature and is determined by the relative magnitudes of the current signal and the current limit reference signal. The current signal is the voltage drop across a very low resistance in the armature circuit, and the reference signal is a fixed voltage which can be adjusted to recalibrate the current limit if desired.

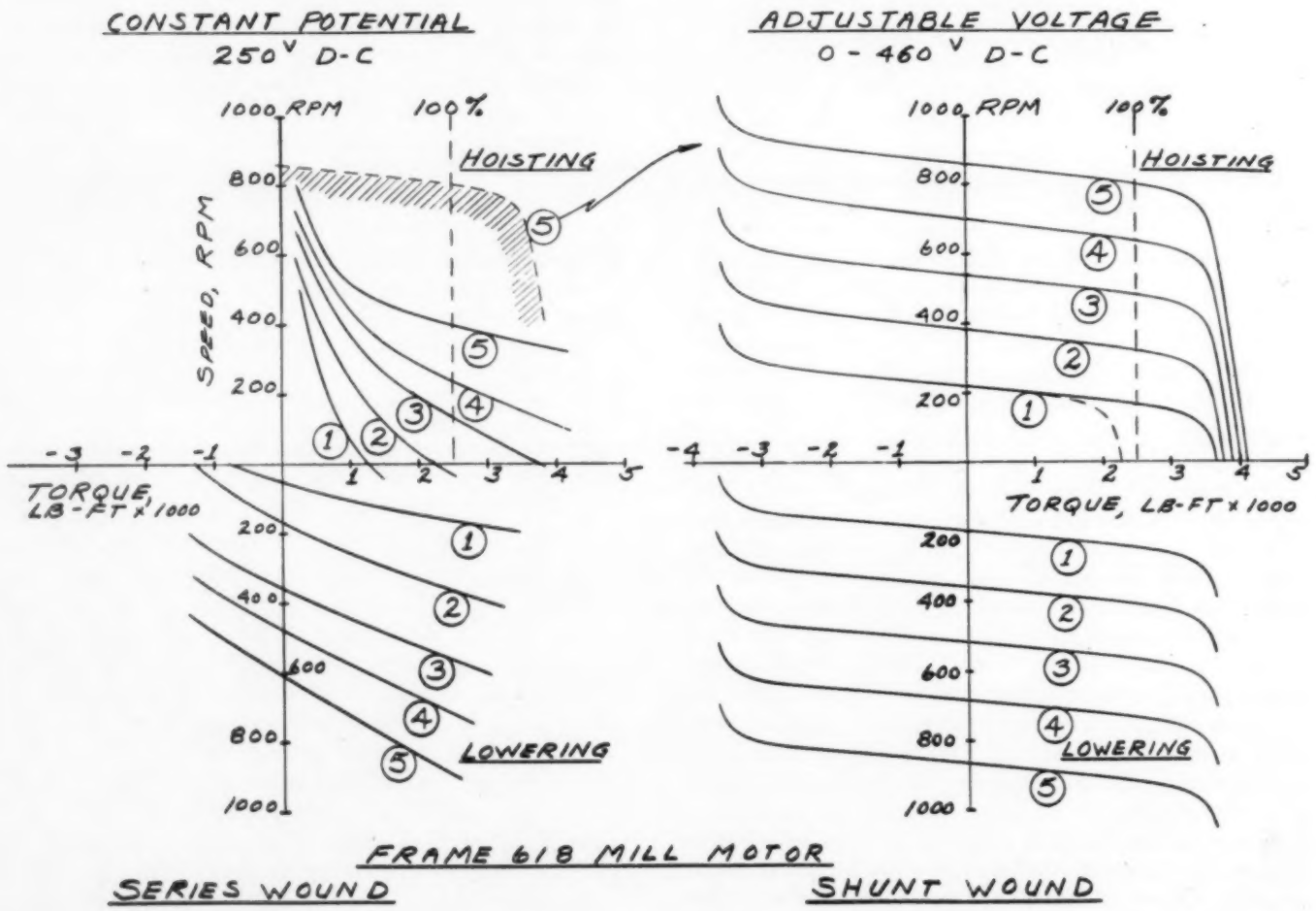
The voltage control functions to maintain nearly zero difference between the voltage signal and the speed reference signal. It does this by varying its output (the generator excitation) so that the voltage signal matches the reference signal.

During speed changes (variation of the speed reference signal by the operator), rapid changes in generator voltage may tend to cause armature currents to flow in excess of desired maximum value. This is where the current limit control steps in. The output of the current limit control is of an "off-on" nature, as has been pointed out previously. If the current signal does not exceed the current limit reference signal, the output is negligible. When the current signal begins to exceed the reference, the current limit control output begins to increase at a great rate, and can quickly reach a magnitude much greater than the voltage or speed reference input signals. The output of the current limit control acts in the voltage control to effectively decrease the difference between the speed reference and the voltage signal. This limits the rate of change of the voltage control output so that the armature current does not exceed the desired limits.

The voltage control and the current limit control are shown as two separate blocks. This is done because functionally they are somewhat independent in their actions, and because physically they are often two separate amplifiers. The voltage control, which is the second and final stage of control, will be a rotating amplifier.

The current limit control, which is a low power output amplifier, may take the form of the rotating amplifier or a magnetic amplifier which is a static device.

Figure 4 — Control characteristics of a typical hoist are shown by the curves.



Either of these control amplifiers for the current limit control will perform satisfactorily. Each has its peculiar requirements, however, which may influence the bridge builder or the control engineer to choose one over the other.

If a rotating amplifier is used for current limit control it will mean six instead of three rotating units to locate on the trolley, and if the magnetic amplifier is used it means a-c current must be brought to the trolley on additional collector rails, or that alternating current must be generated on the trolley for the excitation of the magnetic amplifiers.

For ore bridge adjustable voltage control is doubtful if any control amplifiers currently available will take the place of the rotating amplifier for voltage control. The rotating amplifier is dependable, has reversible output, and is available in output ratings which easily accommodate the d-c generator field requirements on this application.

line in the hoisting quadrant of each set of curves shows the 200-hp rated torque for each motor.

These characteristic curves are typical of the hoist control made available to an operator using a 5-point reversing master switch. Torque is shown on the horizontal scale in units of 1000 lb-ft with the torque values on the right of each set of curves representing positive, or "lifting" direction, torque. The motor speed is shown vertically in units of 200 rpm, the scale running to 1000 rpm in both directions. The top half of each set of characteristic curves shows motor speed with rotation corresponding to hoisting of the bucket.

These curves show two things. They show the more definite speed control which the operator has available to him, both hoisting and lowering, on the adjustable voltage drive as compared to the conventional constant potential drive. They also point out graphically why adjustable voltage drives are providing the increased capacity currently required for ore bridges, and are

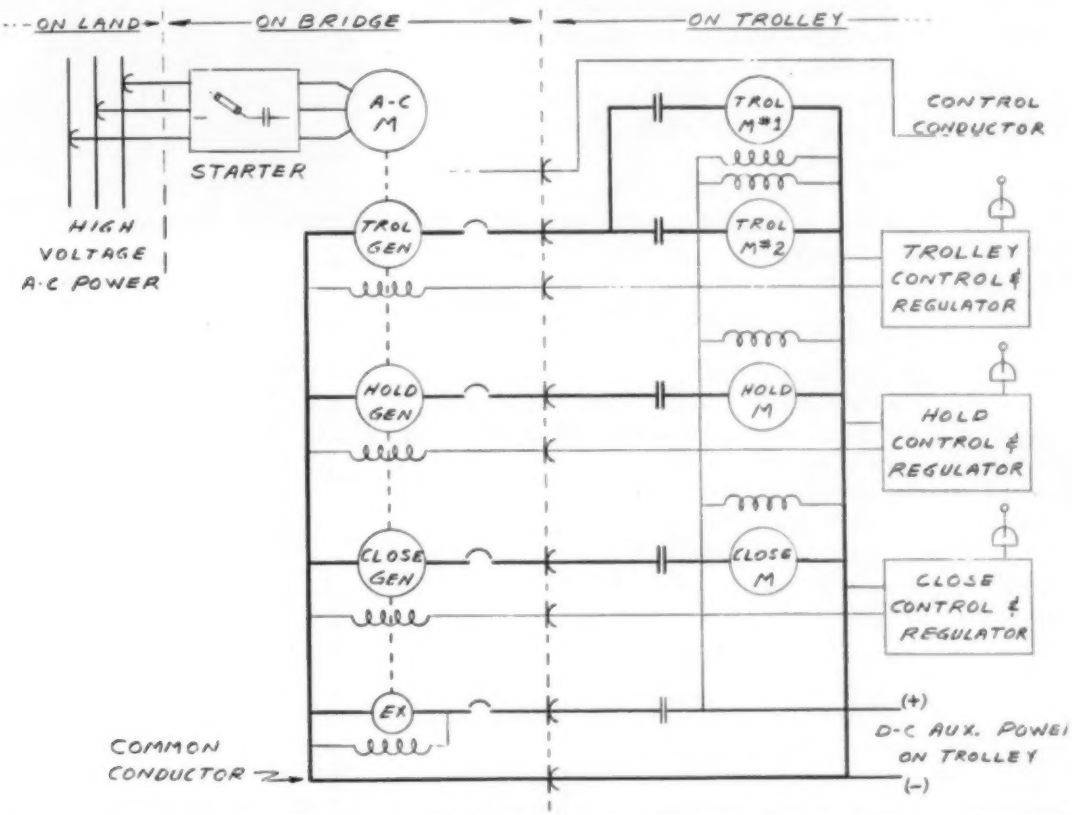


Figure 5 — Power distribution and collectors are indicated on this diagram.

The rotating amplifiers located on the trolley may be driven by either an a-c or d-c prime mover. In the case of an ore bridge with all d-c on the trolley as shown in Figure 5, a constant speed shunt-wound d-c motor would be used. If the bridge builder or steel mill chose to have a-c available on the trolley, an induction motor prime mover would be used. Both systems are in use, and both perform satisfactorily.

Figure 4 shows, side by side, typical hoist control characteristics for a conventional constant potential hoist drive with dynamic braking lowering and an adjustable voltage hoist drive. The curves are motor speed and torque drawn on the same scale. These motors are series-wound and shunt-wound, 618 frame, rated 200-hp continuous, of protected construction, and have rated speeds of 410 and 420 rpm respectively at 230 volts d-c and rated load. The dashed vertical

doing it with 600 series frame mill motors. Note that the adjustable voltage drive motor is operated at double rated voltage and double speed, effectively doubling its shaft horsepower. The dashed, shaded curve in the hoisting quadrant of the constant potential curves is the fifth hoisting speed point of the adjustable voltage drive. The superposition is made to show the increased capacity of the 618 frame mill motor made available by adjustable voltage. This increased capacity, by proper choice of gearing, can be made effective at the hoist machine in the form of very high hoisting speeds with a bucket of 9 to 12 tons capacity, or by using a much heavier bucket and hoisting at more conventional speeds. The latter seems to be the current trend, with buckets of 15 to over 20 tons rated ore capacity being hoisted at speeds up to and in excess of 300 fpm.

The effect of the current (torque) limit control is

shown in the hoisting quadrant of the adjustable voltage characteristic curves. This torque limit gives smoother acceleration and more positive speed response to the operator's master switch position. The dashed line showing more sensitive current limit control on the first point hoisting is a feature sometimes desired by ore bridge operating personnel to facilitate digging operations. The curve is shown to indicate the flexibility of the adjustable voltage control. If it were desirable, different values of current limit could be provided for each master switch point.

Figure 5 shows the main circuits for both power and control distribution and the required collectors on an adjustable voltage bridge. This sketch has been idealized somewhat from an electrical engineers' point of view and is the author's projection of apparent trends in the industry. For instance, single pole contactors are shown in the motor armature circuits on the trolley and a single pole d-c circuit breaker are shown in the generator armature circuit on the bridge. The use of an overall common conductor is shown which accommodates the return loop for both power circuits and control circuits as well as constant potential d-c for control and auxiliary power on the trolley.

The schematic shows, to the left of the vertical dash line at the left, the high voltage incoming a-c power to the bridge which is usually in the range of 2½ to 5 kv. The high voltage collectors may take the form of overhead suspended conductors, or aluminum or steel structural shapes can be used for rigid collector conductors. The collectors between bridge and trolley, shown arranged vertically at the center of this figure, are nine in number, which include four control, four power and one common conductor collectors. These have been applied as steel or aluminum conductors, and are usually structural angles supported in the inverted position underneath the bridge runways.

The single control conductor collector shown will usually be required for setting up bridge travel operations from the trolley.

The industrial type magnetic contactor starter with fused disconnect switch which is shown for the main a-c motor has met acceptance on these installations. The control and regulators for each of the main drives is shown on the trolley. This seems to be a fairly well established method of locating this control, and there are a couple of reasons which are behind it. One is a reluctance on the part of many control engineers to transmit the relatively weak speed reference signal from the operator's master switch on the trolley over a collector rail to the voltage control if this control should be located on the bridge. The object in locating this control on the bridge, of course, would be to further save weight and space on the trolley. Probably the strongest reason for locating the voltage and current limit control on the trolley is one of convenience in adjusting the control. With the main drive regulators and the associated control located on the trolley, coordination of the master switch operation with the desires of the engineer making adjustments on the control is facilitated greatly. During initial adjustment of this control, this convenience is of tremendous value.

We should not overlook the application of adjustable voltage to the bridge travel drives. In order to avoid the expense of additional generator capacity on the main motor-generator set which would only operate intermittently to energize the bridge travel drives, a popular solution is to provide means for disconnecting the hold and close generators from the respective loop circuits leading to those drives on the trolley, and making these generators available, one to each leg of the bridge, to provide adjustable voltage power for the bridge travel motors. At the same time this is done, the hold and close master switches on the trolley become respective controllers one to each end of the bridge. When a change such as this is effected, and if the regulating units are on the trolley structure, then the control for the bridge travel drives must become the typical Ward-Leonard type without regulated current limit features. The generator voltage is increased in increments with time delays relays supervising acceleration and deceleration of the travel drives.

The speed-torque characteristics of the adjustable voltage hoist drives with torque limit features offer certain advantages which favorably affect maintenance of ore bridge structures. The main advantage offered is that the main drives, which are the hold, close and trolley drives, and often the bridge travel drives, become much smoother in operation because of the reduction to a large degree of the shock loads imparted to the structures by the usual constant potential drives. Relatively smooth changes in speed result in lower and

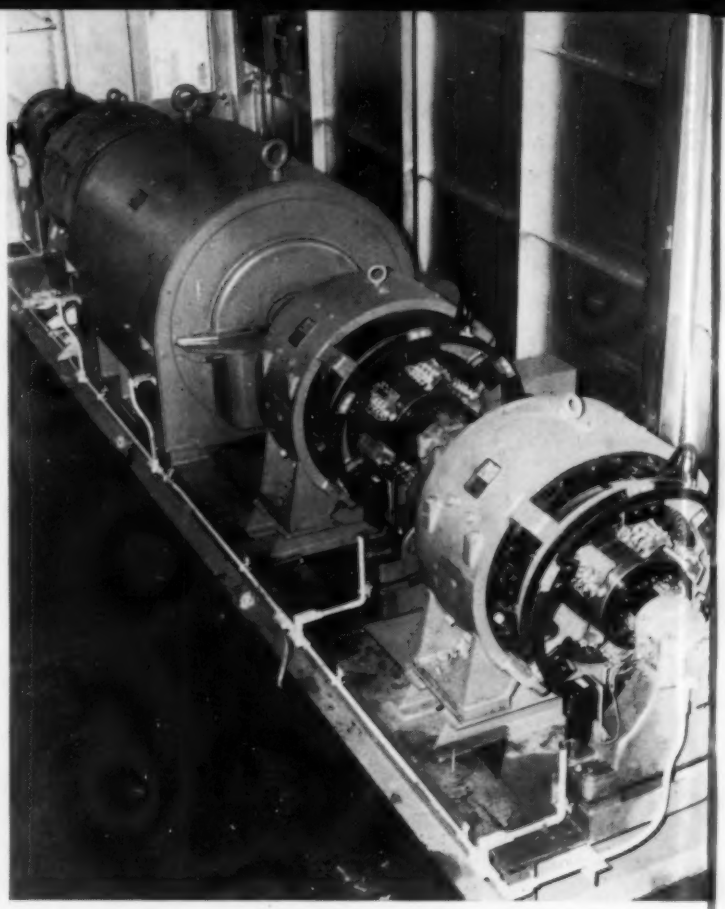


Figure 6 — On the near end of the main drive motor are the hold and close generators, and on the far end of the main drive motor is the trolley generator and just beyond it the constant potential d-c exciter. Because the motor-generator set is usually located in a pressurized, filtered house, a motor-generator set of open construction is employed with its typical saving in weight and cost for a given capacity.

fewer reversals of stress in the structure, with resultant decrease in structural maintenance and increase in structural life.

Another advantage offered by the adjustable voltage drive is the saving in power cost. This advantage is relatively small and would not be a very great factor in determining whether or not the adjustable voltage ore bridge should be applied in a given case. Studies and tests have shown that savings in the neighborhood of one-third can be realized with an adjustable voltage driven bridge over constant potential bridge operation. The main reason for this saving on an adjustable voltage bridge is that regenerative conditions such as trolley deceleration and lowering of the bucket act, to pump power back through the main motor-generator set into the a-c line, whereas on a constant potential drive, these energies are dissipated in resistors on the trolley.

The following advantages and important features of an adjustable voltage bridge will be weighed by anyone considering application of a new ore bridge:

1. Less trolley weight, which is reflected throughout the bridge structure.
2. Higher acceleration rates made possible by the current limit control which permits steady application of accelerating torque as drive speed is increased.
3. Much higher capacity for a given mill motor by virtue of over-voltage operation of the motor coupled with the current limit operation of these motors. This permits the extended use of 600 series mill motors.
4. Greater operator comfort and decreased operator fatigue due to the smoother operation and motion of the bridge and trolley, along with better, more definite speed control. This is an important factor in today's critical and sometimes temperamental labor market.
5. Less mechanical maintenance on the entire bridge structure. The same smooth acceleration and speed control which contributes to operator comfort also decreases the number and magnitude of stress reversals on the bridge structure.
6. A small saving in power cost.
7. Much greater bridge capacity as a result of higher rates of acceleration, higher hoist and trolley speeds, greater bucket capacity, and better control made available to the operator.

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Automation's Effect on Quality Requirements in the steel industry

By ROBERT GUTHRIE

Manager Quality Control, Steel Div., Ford Motor Co., Dearborn, Mich.

. . . . with increased use of automation equipment for steel users, more and more stringent demands are being made on the steel industry to increase uniformity of quality in the steel product . . . . there is a constant challenge to the steel industry to make what is considered impossible today a commonplace product tomorrow . . . .

▲ WITH the changing picture on quality demands, the present topic, covering automation and its effect on quality requirements is of major importance.

A shift from a seller's to a buyer's market results in a complete change in the relationship existing between the customer and the supplier. In one case, the customer is willing to take any material in order to keep his stamping plant going, in a buyer's market this is no longer the case. He becomes very selective and will not put up with any problem in a shipment of steel that might cause trouble. Rather, he insists that the material be exactly as ordered or he will refuse to use it. This type of market condition does much to restore the competitive spirit of American enterprise.

This paper dwells primarily on the effects of automation in body stamping plants and the changes that the Ford Steel Division has found necessary in order to produce the type of product the internal customers want.

The term "automation" was coined a few years ago by the automotive industry, and originated at the Ford Motor Company in the early development period of this process. A simple definition was originally given and this was "the automatic handling of material and parts between progressive production processes." Later it was found that the complex problems hidden behind those simple words were of major proportions and that automation actually entailed a new manufacturing method. Automation is a means of increasing productivity, of obtaining maximum efficiency, and of reducing safety hazards. It does increase product quality and decrease production costs.

Several hundred years ago started what became known as the "Industrial Era." Mechanical power began to replace animal muscle with a corresponding increase in efficiency. In the past twenty years this has developed to a point where practically all major work was being done by machines with the operators serving as a guide to "tell" the machines how the job was to be done, and how often to do it. The consensus of opinion today is that automation is an evolutionary rather than revolutionary development, and represents an accumulation of manufacturing methods, and that this accumulation resulted from a combination of basic planning and greater utilization of specialists in the operating departments. There is not much doubt that this trend will continue so long as the manufacturing industry wages a continuous fight to reduce costs so that the consumption of goods can be spread more widely.

The start of automation, in a sense, began with the early automotive assembly line which Henry Ford introduced early in the present century. The original chassis assembly began with the idea of rolling or pulling the chassis along a route, beside which, operators and stock were spaced.

From this beginning, the moving chain conveyor developed, and the operator was free to spend all of his time on assembly operations.

The conveyor became a symbol of mass production and was used in feeder operations to the main assembly line as well as to perform operations such as storage of materials and auxiliary assembly operations.

It was during this period of development that a program of improved production processes was carried out. Work was simplified and many rearrangements of machines, equipment, and conveyors were made to minimize handling of materials. In other words, the value of the proper plant layout was recognized. As a result, production went up while costs were substantially cut.

This expansion program was made to produce an automobile of a much smaller and simpler design than known today. Machines were placed very closely to-

gether with material handling accomplished by means of overhead conveyors.

As the automobile became more and more an economic necessity of modern life, public demand brought about changes in design, styling, size; the product became more elaborate, and production processes became more complicated.

To meet these changes in styling, facilities were rearranged to use, as much as possible, the existing facilities without major revamping. This was a satisfactory approach to the problem until, in very recent years, it became apparent that the products had changed so radically that major changes in our production processes were required in order that volume production could be accomplished in an efficient manner.

The early automation programs were centered about rearrangement of standard and existing machines to connect them with mechanical devices which would eliminate the inherent delay caused by manual handling with resulting lower production costs. At the present time, our new programs are based upon the installation of machinery and equipment designed with automation in mind.

Automation devices are designed to move parts, sheets and strip into and out of production machines, turn the part over, rotate it, remove scrap and other related functions. Scrap removal on a continuous and automatic basis was a necessity in both machining and stamping operations. These devices are timed with the operation and function ordinarily without any assistance from the operator.

A finished piece of automation equipment consists of standard elements such as conveyors, air, hydraulic, and electrical control mechanisms arranged to obtain the proper movement for elimination of unnecessary manual operations.

It has been found that a variety of materials can be handled with substantial savings and at the same time eliminate hazardous handling such as in stampings, heat treat operations, forging and machining operations; and that, in many respects, automation is the extended usage of conveyors which played an important part in the early development of mass production methods.

In line with the progress accomplished in the automotive industry on automation, the steel industry has also progressed in this direction.

The continuous strip sheet mill is a very good example of automation, although it apparently has never been considered in that light. It does involve a series of rolling operations in which the speeds of each mill are automatically regulated to compensate for the increase in the speed of the steel strip as it is thinned down from a slab. Anyone who remembers back a few years ago to the old hand mill and its manual work will recognize that the continuous mill frees labor of handling metal from the time the cold slab is pushed into the heating furnace until the coil of strip steel is pushed off the coiler. There is no question regarding the increased efficiency nor the increased uniformity of quality from this type of product as compared to the old hand mills.

It is a well known fact that technological developments in one industry have a considerable effect on other industries closely associated with it. This has been the case between the automotive and steel industries as a result of automation developments. The use of automation equipment on a wide scale in the automotive plants has required changes and improvements in steel industry practices in order that a satisfactory product could be furnished for the new processes.

During the pre-automation period, shipments of steel to stamping plants were primarily in the form of sheets. These sheets were hand fed into the blanker or draw dies for the forming of panels which were then handled by manpower through each succeeding operation. At that time quality standards in the steel industry were different from what they are at present. In the pre-automation days, since the majority of material was to be shipped in sheets, any coil containing defective metal could be processed through the entire mill and the defective material thrown out at the shears. In addition, if all the defective metal did not get thrown out and some was allowed to go to the customer's plants, usually an arrangement could be made to throw any off-quality sheets out of the bundle while the material was in front of the press. This, of course, created a certain amount of unhappiness in the customer's plant; but on a whole, so long as this condition was not too prevalent, a good spirit of cooperation did exist. Such is not the case, however, with automation.

In the Ford Steel Division, going back to the pre-automation days, a 20,000-lb ingot was used giving four slabs, each weighing approximately 4300-lb. These slabs were inspected and hand-scarfed to remove obvious surface defects. These conditioned slabs were, in turn, rolled into coils and welded into a composite coil at the pickle lines, with an inside diameter of 30 in. and a maximum outside diameter of 50 in. The average coil weight was approximately 13,000 lb and each coil consisted of from two to three welds which are in themselves a hazard in the cold reduction mills so far as torn sheets and off-gage is concerned. The elongation necessary to prevent the formation of stretcher strains at the temper mills was arrived at by scribing. As this could only be done at slow speeds, the ability of the operator to correct his mill at the higher speeds, based upon the readings taken at the slow speeds, was always a hazard. During this entire period, a flat sheet was not an absolute requirement, although the commercial standards of flatness were adhered to.

With the move toward automation or mechanical handling of the material through the press lines and integrating a number of draw and form operations into one press, more and more parts were changed from sheet requirements to coils. At the same time, with the improvement of decoiler mechanisms and handling facilities, the demand for larger and larger coils became more prevalent. The economics involved, required changes in the steel industry's equipment, so that a larger and better quality coil could be produced. It should be pointed out at this time that the advantages were not only in the stamping industry, it was definitely advantageous to Ford's Steel Division, since the larger packages tended to decrease handling costs. It also decreased the hazards of small coils and increased productivity.

When the changes to be made were first surveyed, there were many bottlenecks that had to be removed and which had developed since the first installation of the mill. Starting at the open hearth, the size of our molds were increased to give larger ingots. As part of this picture in the open hearth, bath immersion temperature control was adopted in order to insure a more complete picture of the temperature of the metal. This adoption could be classified as an aid to operations in maintaining a minimum amount of skull and at the same time, not develop mold stickers. It could also be considered as a means of getting better quality by tapping heats at the optimum temperature to produce a steel best suited for the particular application for which intended. The bath temperature by itself was not sufficient, although, it gave a better picture of the temperature of the metal. It was still necessary to get the metal out of the furnace at the time best suited. Jet tapping was started as a protection against poor hard taps with all the corresponding quality conditions that normally could develop. At the pouring platform, the larger molds required that new procedures be developed for handling. At the same time, changes in design on nozzle sizes and stopper heads had to be incorporated. Methods had to be developed to properly cool, coat and cycle these larger molds to achieve the best quality product possible. The handling problems using the larger ingots also increased, requiring the establishment of entirely new heating and holding practices in the soaking pits. It was necessary to develop a flow of material from the pouring platform in the open hearth to the soaking pits which would allow the ingots to be charged and brought up to heat without excessive forcing which would result in the overheating of the surface and, yet at the same time allow sufficient solidification time to prevent the occurrence of soft and mushy ingot centers. At approximately the same time all of this was developing, new and additional soaking pit facilities were being added. Although there were some problems of minor nature that developed in this major change-over, in the overall, the new equipment functioned very nicely with a minimum of trouble.

The innovations that had been added decreased tendencies toward bottlenecks; however, there still was the problem of moving the material into the hot strip mill as soon as possible after slabbing. This could not be done with the conditioning facilities then available. Therefore, a new automatic slab scarfer was added into the line of operation. This scarfed the top and bottom side of each slab simultaneously, doing away, to a large extent, with the previous handling and hand scarfing that had been necessary.

The increased slab size resulting from a larger ingot gave larger coils and necessitated changes in our composite coil size. As we mentioned previously, 50 in. was the maximum outside diameter. Under the new program, the intention was to go to a 24-in. inside diameter with a 66-in. outside diameter, with coils weighing approximately 850 lb per in. of width. This meant an actual coil weight of approximately 50,000 lb on the average width product, and as these new slab sizes did not lend themselves to an even multiple, it was necessary to develop a footage system of measuring the coil, so that the maximum uniform size packages could be made. It goes without saying that the more uniform the package was, so far as weight was concerned coming off the pickle lines, the more efficient the operation of cold rolling and annealing became. With the development of this footage, it became more essential than ever that defective material in a coil be held to a minimum. On the old setup, any defect occurring around a weld area could normally be cut out before welding with not too much loss of material or trouble. With the new setup, much more care had to be taken to insure a scale-free sheet, and the gage variation from one end of the hot band to the other had to be minimized as much as possible while still getting a flat sheet.

Some of these conditions could be corrected on the hot strip mill; therefore, larger and more modern reheat furnaces were built which allowed more uniform heating of the slabs, tending to aid in giving a more uniform condition throughout the coil so far as microstructure and gage was concerned. Additional high pressure sprays were installed to remove the scale. An x-ray gage was installed on the hot strip mill to give a continuous record throughout the entire coil and indicate to the operators the gage or thickness at that moment. An improved conveyor system was installed to facilitate handling and reduce potential damage to coils. Storage facilities for hot bands inside the building were initiated to decrease rust and the possible formation of a pitted surface. As mentioned previously, the more uniform the gage of the hot band, the less shock there is at the weld area in the cold mill; therefore, the more uniform can be the gage throughout the entire cold rolled coil. At the present time, a width-gage is being examined for installation on the hot strip mill which will allow for closer control of the width dimension. This, to date, has not been too serious a problem in the Ford mill; however, we feel that being able to observe this condition will help in decreasing trim loss and also give better control of the entire product.

The next major change was at the pickle lines. A faster, more efficient means of scale removal was essential. The original installation consisted of a batch type continuous pickler, which, although serving the purpose of its original installation, did not lend itself to increased quality and productivity under the new plans. Therefore, continuous cascade lines were adopted. Although this increased the acid costs somewhat per ton of steel pickled, the better scale removal job being done more than compensated for this loss. At the same time that the lines were shifted over to a cascade system, water sprays were installed to rinse the sheet coming out of the pickler and improved hot air blasts added to dry the sheets. All of the cold rolled product is side trimmed to the specified width as it comes off the pickle lines.

Stationing an inspector at this point to check sheet surface for scale, scabs, lamination, scratches and gage is a definite aid in first, preventing defective material from getting into the cold reduction mills and causing numerous roll wrecks and roll changes; and, second, serving as a very good check point on the succeeding operations as well as those already passed. With a more competitive steel market, customers expect to have

prime material delivered at the time they have specified, so all efforts have been turned to trying to give the customer the kind of material he wants according to his schedule. As it takes approximately four weeks to process cold rolled sheets, it should be quite obvious that defective material must be caught at the earliest possible operation to keep from upsetting both mill schedules and customer schedules.

In the cold reduction operations, improvements and innovations have also been made to produce a more satisfactory product for automation. These mills, which originally had recirculating cooling systems with an oil solution, were changed to a direct spray system with the rolling oil dripping on the rolls. This had several advantages; first, it aided in preventing recirculation of any steel particles or dirt which would tend to mark the rolls. Along with the marking of the rolls, of course, was the problem of this dirt collecting on the mill stands and falling to the sheets at the most inopportune times; secondly, it gave better control of roll shape and, in turn, sheet shape by allowing for temperature cooling control on the mill.

Looking at the mill's cleanliness, the more that can be done to prevent any accumulation or dirt, the less possibility there is of either marking the rolls or starting the formation of steel flakes which will cause pimples in the finished panels.

Better control of shape means a flatter sheet with less tendency toward buckles, sticking in the anneals, or out-of-flat, which are bad any time but become much more detrimental when using automation equipment.

In the future there will be an x-ray gage on the cold mill. At the present time, flying micrometers are used, which, although they do tell the story of the gage on the sheet, can very easily become damaged due to mill difficulties that may develop. The present gage used holds within the established industry standard; however, anything that can be done to improve the gage consistency will work to everyone's satisfaction. At the same time, the closer to the mean gage the material can be held, the greater the uniformity of performance.

The annealing department was completely re-built. In the initial installation, all annealing was done in single stack, electrically heated furnaces. These were satisfactory insofar as requirements at that time were concerned, but greater care had to be taken in controlling the per cent reduction at the cold reduction mills, the coil tension at these mills and, also, the annealing temperature to prevent the occurrence of excessive stickers. These furnaces were capable of producing approximately 18,000 tons of annealed stock per month, and with all the other major changes that had been made, it was very evident that a serious annealing bottleneck could exist at this point. Therefore, modern, gas-fired, 4-stack annealing furnaces were installed to replace this obsolete equipment, and as coils with a wall thickness of from 18 to 21 in. as compared to our original 10 to 12-in. wall thickness were being considered, a means of recirculating hot gases to derive the maximum efficiency of the furnaces was essential.

A new four-high temper mill was installed replacing two, two-high mills and extensometers were added to keep the roller and inspector informed of the elongation of the steel at all times. In addition a control is to be installed to aid in furnishing an evenly wound coil. This device includes a hydraulic piston attached to the entry reel, moving it to compensate for runout of the sheet through the mill. The piston's hydraulic system is actuated by means of an air stream from a scanning head focused on the edge of the sheet. An evenly-wound coil is a major asset in automation as the uncoiler usually runs free so that any unevenness of coil wrap tends to allow the coil edges to be damaged either in the coil box or in the handling with resultant stoppage or slow-down of the automation while the damaged material is removed.

This entire paper has tied in the operating units and the changes that were made in both equipment and process to satisfy the customer requirements, primarily, in the body stamping plants. However, automation is by no means limited to stamping plants. Other Ford manufacturing divisions are moving in this same direction, namely; the Cleveland engine plant, the Cleveland foundry and the Monroe plant. The coil spring manufacturing operation at the Monroe plant is of special interest from a metallurgical point of view as a result of the extensive use of automation. The rods are heated in a rod furnace prior to coiling, then follow through the sequence of operations: roll formers to flatten the end of the rod, hot rod coilers, quench tanks, draw furnaces and shot blast cleaning machines, with no interruption in the flow of material from the time it goes into the furnace until the shot blasted spring is taken from the conveyor. The coiling speed is fast enough to allow the springs to be quenched from the coiler without any reheating. This, of course, requires that close metallurgical control be exercised both in incoming raw materials and also the process itself. The problems arising in each of these areas, whether it be the stamping plant, the Cleveland foundry, the Cleveland engine plant or the Monroe plant, are, of course, those peculiar to that operation; however, the quality aspects remain the same.

This in turn means closer controls in the manufacturing of the materials for the plants so that the flow of material through the automation processes can be accomplished with a minimum of trouble.

With the more rigid demands for quality that are developing daily from customers, the steps that have been taken will aid in meeting their requirements since all of these improvements are changes that, although not directly due to automation, have all been aimed at one thing — to give the customer the quality of product that he requires.

With the contemplated increase in automation equipment, there will be more and more stringent demands on the steel industry to more closely approach a uniformity of quality in their product comparable to that from a punch press. It presents a continuous challenge to the steel industry to prove that what today is considered impossible will be commonplace tomorrow to the maximum benefit of both the customer and the supplier.

CURRENT AISE DISTRICT SECTION MEETING NOTICES

BIRMINGHAM SECTION

Monday, April 30, 1956 — Cocktail Hour and Dinner 6:30 P.M., Meeting 8:00 P.M.

"Electro-nomics," by Carl Vossberg, Chief Engineer of Southeastern Electronic Laboratories, Umatilla, Fla.

Thomas Jefferson Hotel, Birmingham, Ala.

BUFFALO SECTION

Tuesday, April 10, 1956 — Dinner 6:30 P.M., Meeting 8:00 P.M.

Inspection Trip — Atlas Steels Ltd., Welland, Ont., Canada.
"Continuous Casting," by W. Jacobs, Development Engineer, Atlas Steels, Ltd.

Hotel Sheraton, 715 Delaware Avenue, Buffalo, N. Y.

CHICAGO SECTION

Tuesday, April 3, 1956 — Dinner 6:30 P.M., Meeting 7:45 P.M.

"The Use of Electrical Computers in Solving Steel Mill Problems," by W. E. Miller, Manager, Steel Mill Engineering, General Electric Co., Schenectady, N. Y.

Phil Smidt's Restaurant, 1205 N. Calumet Avenue, Hammond, Ind.

CLEVELAND SECTION

Tuesday, April 17, 1956 — Inspection Trip 2:00-4:30 P.M., Dinner 6:30 P.M., Meeting 8:00 P.M.

Inspection Trip, National Advisory Committee for Aeronautics Division of Lewis Flight Propulsion Laboratories.

"Research for Tomorrow's Aircraft," by Willson H. Hunter, Aeronautical Scientist, National Advisory Committee for Aeronautics, Division of Lewis Flight Propulsion Laboratories, Cleveland, Ohio.

Dinner and Meeting: University Club, 3813 Euclid Avenue, Cleveland, Ohio.

DETROIT SECTION

Tuesday, April 10, 1956, Dinner 6:30 P.M., Meeting 8:00 P.M.

Election of Officers.

"Protecting Your Ideas," by John S. Lieb, Asst. Patent Attorney (in charge), Allis-Chalmers Mfg. Co., Milwaukee, Wis.

Dinner and Meeting — Parlors E, F and G, Horace Rackham Educational Memorial Building, Detroit.

LOS ANGELES SECTION

No April meeting.

PHILADELPHIA SECTION

Saturday, April 7, 1956 — Dinner 6:00 P.M., Meeting 7:00 P.M.

"Maintenance of Weighing Scales," by G. E. Evans, Scale Repair Foreman, Mechanical Department, Bethlehem Steel Co., Sparrows Point, Md.

"Development of Methods of Reclaiming and Processing Scrap from Steel Plant Slags and Refuse," by Lawrence J. Fritz, Assistant to General Superintendent, Heckett Engineering, Inc., Butler, Pa.

"Standards and Classification of Lubricants for Steel Mills," by J. D. Lykins, Chief Lubrication Engineer, Wheeling Steel Corp., Wheeling, W. Va.

Engineers' Club, 1317 Spruce St., Philadelphia, Pa.

PITTSBURGH SECTION

Monday, April 9, 1956 — Social Hour 6:00 P.M., Dinner 7:00 P.M., Meeting 8:00 P.M.

"Development of Automatic Gage Control for Tandem Cold Reduction Mills," by R. W. Holman, Assistant Vice President — Research, United States Steel Corp., Pittsburgh, Pa.; M. W. Cannon, Development Engineer — Industry Control Department, General Electric Co., Roanoke, Va.; and H. S. Maxwell, Steel Mills Systems Application Engineer, General Electric Co., Schenectady, N. Y.

University Club, University Place, Pittsburgh, Pa.

ST. LOUIS SECTION

Data not available.

SAN FRANCISCO SECTION

No April meeting.

YOUNGSTOWN SECTION

Monday, April 23, 1956 — Social Hour 6:00 P.M., Dinner 7:00 P.M., Meeting 8:00 P.M.

"What's New In Sintering" by P. Gallagher, Chief Engineer, T. Ban, Director of Research, and Harold Raven, General Manager, McDowell Corporation, Cleveland, Ohio.

Mahoning Country Club, Girard, Ohio.

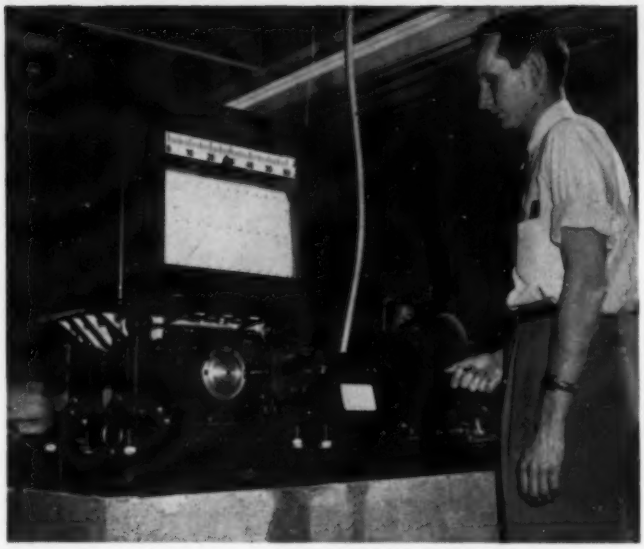


Figure 1 — A vibration unit is installed to test the instrumentation equipment in the laboratory.

INSTRUMENTATION AND CONTROL IN STEEL PLANTS

By J. R. GREENE
Manager
Steel & Ceramics Industrial Div.
Minneapolis-Honeywell Regulator Co.
Philadelphia, Pa.

. . . . for control of steel plant processing operations, automatic regulation is often obtained by a combination of electric, pneumatic, or hydraulic systems . . . . production is increased and fuel requirements lowered with the use of instruments and controls . . . .

▲ IN offering comments upon the applications in steel plants of modern instrument and control systems, it is well to first consider the requirements placed upon such equipment by the conditions under which they operate.

The opinions expressed are based upon observations extending over 25 years, and attempt to be unbiased concerning the products made by my company although the illustrations are drawn from the material available from that source.

If one most desirable characteristic of steel plant instrumentation were to be selected, it would probably be "ruggedness." Stated more specifically, this might be expressed as the ability to provide good service life under severe conditions of vibration and high ambient temperatures, as well as dirty and corrosive atmospheres. Of all the heavy basic industries, the steel plant —from coke works to finishing and coating—presents the greatest variety of "tough conditions" for instrument installations. The mills, machinery and equipment are massive, and predominately "hot," while the fuzzy gloved operators who make use of the instruments are more familiar with tongs, shovels, sledges or a 36-in. wrench, than with precision tools.

INSTRUMENT DESIGN

Many advances have been made over the years to improve the "ruggedness" of industrial instruments. In the field of temperature measurement, the earliest mechanical expansion units were of simple design and long life, but they could not keep pace with increasing demands for accuracy, nor the requirements of control. The thermoelectric method of temperature measurement progressed over many years, through stages of design principles and compensation for atmospheric conditions. The commercial availability of electronically operated measuring systems within the past ten years has been a major step in meeting the operating requirements of the steel industry. Although elimination of the pivots, suspensions and mechanical balancing of galvanometer systems has provided increased speed, accuracy and sensitivity, as well as narrower spans and lower temperature ranges, the major contribution has been found in the ability to give continuing service with a minimum of maintenance under the operating conditions encountered in the steel industry.

Looking to the future, one can reasonably anticipate that the transistor development will add further simplification and ruggedness to industrial instruments and control systems, whenever the volume manufacturing techniques for these new components can provide consistency and reproducibility in circuits to replace the use of vacuum tubes.

The development of miniature instrument designs for use in large centralized graphic panels has changed the instrumentation methods for many of the continuous process industries, but holds no particular advantage for application to the individual units which are employed in the steel plant.

Instrument manufacturers continue to test and improve the ability of all designs to withstand severe

operating conditions. As an example, Figure 1 shows a vibration and life testing unit installed in our research and development laboratory for subjecting instruments to vibration frequencies over a range of 5 to 65 cycles per second. Figure 2 illustrates a high temperature oven where accuracy and component life of all types of meters are tested over a wide range of ambient temperature conditions.

Similar improvements in the design of primary elements, as well as measuring instruments and control systems have produced more rugged flowmeters, pressure gages, gas analysis units and gaging equipment of all types.

An outstanding example of improvement in primary elements is to be found in the various designs of radiation elements which have been made available during the past ten years. The ability of these units to provide stable and interchangeable measurements under varying ambient and atmospheric conditions, as well as measuring small targets and low temperature ranges, has extended their efficient utilization in the steel plant, from blast furnace and open hearth, through the reheating, rolling and heat treating operations to the coating and finishing processes which approach atmospheric temperatures.

Figure 2 — Accuracy under high temperature conditions is checked in an oven.

CONTROL CHARACTERISTICS

Having taken this brief look at what we are all striving for in steel plant measuring instruments, look at the subsequent automatic control functions, in order to ascertain how they are best accomplished, as well as by what methods and means.

In determining the controllability of a steel plant process, only infrequently will a single variable be found that may be used to control its operation. Instead, a large number of related variables must be integrated into the control system. Despite the complexity and widely different function of many of these processes, similar control characteristics have been observed in all of them.

One or more of the following characteristic common denominators may be expected to exist in each unit process.

1. The instrumentation must be an integrated component of the process.
2. Input and output material and energy flows must be stabilized.
3. An optimum rate of reaction, heating, or cooling must be maintained.
4. Product and process equipment may need to be protected from damage, caused usually by temperature.

The selection of a method to be employed in controlling any process or its individual variables finally resolves itself into the type or mode of control which must be employed to maintain the process within allowable limits of variation.

Most engineers are familiar with the technical terminology, such as two-position, floating, pulsing, proportional action, automatic reset and rate response, which has been used to describe these types or modes of control action. This paper is not the proper place to dwell upon this phase of control engineering. It all boils down to whether cycling or hunting is permissible, by contrast to stability of control, and the allowable deviations caused by load or throughput changes as well as interruption in the process. Put that information together with some knowhow, and any experienced instrument engineer can come up with a suitable type or mode of control to be employed.

CONTROL MEDIA

The question as to what media should be used to accomplish the required control action has long been a subject of controversy or discussion within the steel industry.

On the basis of their actuating medium, control systems may be divided according to the following classifications:

1. Self-actuated control.
2. Electric control, including electronics.
3. Pneumatic or air-operated control.
4. Hydraulic or liquid-operated control.
5. Mechanical control.

It is entirely natural that past experience, familiarity, and training will unconsciously influence the selection of control mediums by instrument and plant engineers. In the past, the steel industry has been predominantly electrically and hydraulically minded. In recent years, additional experience with air-operated systems, combined with the increasing complexity of process characteristics and the greater requirements for close control, have illustrated to steel operators the simplicity and precision of this actuating medium when proper engineering has been applied to the furnishing of a sufficiently clean and dry air supply.

In determining, from an unbiased standpoint, the medium of control to be used for a specific application, it is necessary to first analyze the process characteristics, the variables which must be controlled and the

precision required in order to select the proper type or mode of control. The selection can then be made of the medium for actuating that type based upon its simplicity, precision, flexibility, ease of maintenance, reliability and cost. A combination of several different operating mediums in the same control system may be used to secure the most efficient overall operating results, with a minimum of control equipment.

One side comment is offered in this connection. For an efficient maintenance organization, it is unquestionably wise to combine in one instrument department the responsibility of all instrument and control equipment, regardless of whether it is electric, pneumatic or hydraulic in operation.

Now let us consider various control media in further detail.

Self-Actuated Controllers—These are usually of the on-off or narrow range throttling types and may be of mechanical expansion, tubing and bellows, or pressure-actuated construction. They are usually non-indicating or non-recording, with control settings made on empirical scales. Such controllers find many applications as independent stabilizing or limiting controls in regulating oil temperatures, steam and fuel pressures or acting as safety devices. Their construction is relatively simple and their operation is reasonably rapid.

Electrical Control Systems—These include the conventional contact or relay devices, as well as electronic methods where electric currents are transmitted, amplified, or altered in their characteristics, by passing through vacuum or gaseous tubes. The latter methods have been developed extensively in the operation of controlling instruments, relays and safety devices, in order to secure speed and sensitivity of operation. With the developments being made in this field, it is reasonable to expect the extension of electronic principles to the operation of electric control mechanisms for obtaining a flexibility now found in other actuating mediums.

Electric control systems require a constant supply at a proper voltage. This latter point is frequently overlooked in steel plants which have overloaded electrical systems with extreme fluctuations of load.

The rate of response of electric control is determined by the mechanism speed, which is usually constant and fixed, regardless of the magnitude of demand. Frequently, an intermittent operation either in the controller or control mechanism is required to avoid oscillation. By means of electrical or mechanical devices, all types of control can be supplied with electrical operation. Upon interruption of actuating medium, the control mechanism, unless of the solenoid or spring loaded design, normally remains in its last position. All power requirements can be met by proper motor size. When intermediate relays or interrupters are required between the controller and mechanism, some control signal transmission lag may be introduced. When explosive, contaminating or dirty atmospheres are encountered, suitable protection must be provided. The distance between instrument and motor is unlimited.

Air-Operated Controllers—These are normally continuous rather than intermittent in nature and are capable of positioning to almost an infinite number of steps. Power requirements can be handled by the size of the diaphragm or piston area in the control mechanism, and positive positioning is assured by position relay devices. Air controls usually incorporate pilot valves or relays which provide immediate response in the control mechanism and therefore, minimize the control signal transmission lag. All types of control are available in air-operated equipment, and the throttling and automatic reset or rate response type are inherently handled with greater simplicity than by electrical methods. Upon interruption in the control medium, air systems are normally designed to move to the "safe" position. Proper cleaning and preparation of the air supply, occasionally making use of standby or storage units, assure a continuous and trouble-free supply with a minimum of attention. Figure 3 illustrates the components of a conditioning system for plant air when used for control purposes, as successfully used by a number of steel plants for over ten years. Explosive atmospheres present no hazard, and contaminating or dirty atmospheres are not troublesome due to the self-purging nature of air control. By the use of "non-bleed" pilot valve construction, air is consumed during valve movement, and therefore, require a minimum of air consumption.

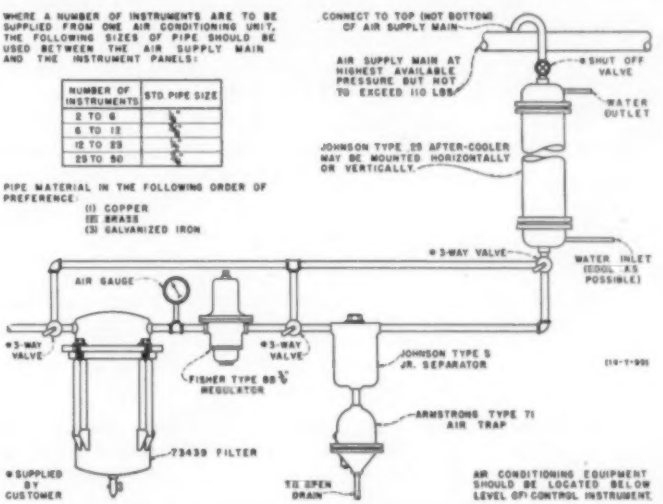

WHERE A NUMBER OF INSTRUMENTS ARE TO BE SUPPLIED FROM ONE AIR CONDITIONING UNIT, THE FOLLOWING SIZES OF PIPE SHOULD BE USED BETWEEN THE AIR SUPPLY MAIN AND THE INSTRUMENT PANELS:
NUMBER OF INSTRUMENTS
STD PIPE SIZE
2 TO 6
6 TO 12
12 TO 25
25 TO 50
PIPE MATERIAL IN THE FOLLOWING ORDER OF PREFERENCE:
(1) COPPER
(2) BRASS
(3) GALVANIZED IRON
CONNECT TO TOP (NOT BOTTOM) OF AIR SUPPLY MAIN
AIR SUPPLY MAIN AT HIGHEST AVAILABLE PRESSURE BUT NOT TO EXCEED 110 LBS
*SHUT OFF VALVE
WATER OUTLET
JOHNSON TYPE 25 AFTER-COOLER MAY BE MOUNTED HORIZONTALLY OR VERTICALLY.
*3-WAY VALVE
WATER INLET (COOL AS POSSIBLE)
AIR GAUGE
*3-WAY VALVE
*3-WAY VALVE
JOHNSON TYPE S JR. SEPARATOR
FISHER TYPE 99 REGULATOR
ARMSTRONG TYPE 71 AIR TRAP
73439 FILTER
*SUPPLIED BY CUSTOMER
TO OPEN DRAIN
AIR CONDITIONING EQUIPMENT SHOULD BE LOCATED BELOW LEVEL OF CONTROL INSTRUMENT.

Figure 3 — A conditioning system is desirable for cleaning air to be used in control instruments.

Hydraulic Controllers—These are quite similar to air-operated equipment in many of their characteristics, but usually involve more extensive supply and return systems which should be protected against the possibility of fire hazards, and leakage loss of control fluid. To date, these systems have not been built into the form of indicating or recording controllers.

Power requirements are handled with somewhat smaller units than air-control, and the non-compressibility of the actuating medium permits greater speeds of operation. In practice, this characteristic frequently requires dampening to avoid hunting, as well as protection against effects of fluid temperature changes.

Mechanical Control Systems—These are of minor importance in steel plant control practice, the principal mechanical function being incorporated into the design of control instruments and operating mechanisms which are actuated by other mediums.

TABLE I

Comparative Advantages Between Electric and Air-Operated Control Systems

	Electric control	Air Control
Requirements for Actuating medium	Uninterrupted electrical supply at proper voltage and frequency.	Constant supply of reasonably clean and dry air or non-corrosive gas.
Types of control available	Two-position. Floating. Pulsing. Narrow-range proportional. Proportional with automatic reset. Certain forms of rate response.	Two-position. Narrow-range throttling. Wide range throttling. Throttling with automatic reset. Rate response.
Simplicity of controller	May be simpler than air for elementary types. Requires auxiliary relays for advanced types of control.	Performs all the control functions in the instrument. Simpler than electric for advanced types.
Simplicity of control mechanism	Incorporates part of balancing or control functions.	Extremely simple.
Power of control mechanism	Inherently provides large starting force.	May require positioner for high starting force.
Number of control mechanism positions	Usually a definite number (less than 100) of available positions.	Over 200 positions with positioner, over 600.
Speed of response of control mechanism	Limited by maximum mechanism speed.	Practically unlimited. Usually faster than electrical.
Resistance to corrosive, contaminating, or explosive atmospheres	Instrument and mechanism both may require special contacts and protective enclosures or explosion-proof construction. Occasionally requires air purging.	Self purging and absence of contacts provide inherent freedom from all corrosion, contamination or explosive hazards.
Practical distance between controller and mechanism	Unlimited.	Limited.
Operation on medium failure	Usually remains in last position.	Usually moves to "safe" position.
Initial cost	Usually higher than air for complete installation of equivalent type of control.	Usually lower than electric for complete system including mechanism and valve.
Installation cost	May be lower where wiring is not elaborately housed and distance is considerable between controller and mechanism. Usually greater with advanced types of control.	If compressed air is not available, usually higher for small installation due to compressor cost. Does not increase with advanced types of control.
Operating cost	Energy less costly. Maintaining cost higher.	Energy cost usually higher. Less maintenance cost, particularly lower on operator.
Ease of maintenance and adjustment	With equivalent basic training usually more difficult for advanced type of control due to complexity and adjustments.	With equivalent basic training, usually simple, particularly with advanced type of control.

A summary of the comparative advantages between electrical and air operated controls is shown in Table I.

The steel industry with its heavy investment in massive production equipment, continually places demands upon its engineering and combustion departments, to provide ways and means of improving product quality, extend the economic life of equipment, lower fuel costs and devise new methods of processing. A few examples of typical control systems or new instrumentation approaches to the solution of specific problems can be of value at this time.

FUEL UTILIZATION

In order to secure maximum overall efficiency from the available fuel supplies, much attention is now being placed upon multiple, alternate or peak substitution of different fuels, in order to avoid bleeding blast furnace gas or constructing additional holder capacity from coke plants, as well as provide facilities for rapid and smooth conversion to liquid fuels upon interruptions in gaseous fuel supplies.

The instrumentation and control methods employed in some of these fuel systems simply make use of metering designs capable of measuring and controlling different liquid or gaseous fuels in terms of equivalent Btu. Figure 4 shows such an installation, as duplicated on 12 open hearth furnaces in one shop. The two electronically-operated flowmeters indicate, record, and totalize fuel flow as well as automatically control the firing rates. One meter can alternately measure oil or tar, while the other handles natural or coke oven gas. Note the dual large indicating scale calibrated in both cu ft and Btu or gallons of oil equivalents. Figure 5 illustrates the meter body and single control valve for maintaining any desired flow of either coke oven or natural gas.

Most of the new or modernized multiple-fuel systems employ some form of totalization in terms of heating value. This function may be secured by mechanical; electrical, or penumatic means after extracting the square root metering characteristic. Figure 6 is a schematic diagram of such an installed system

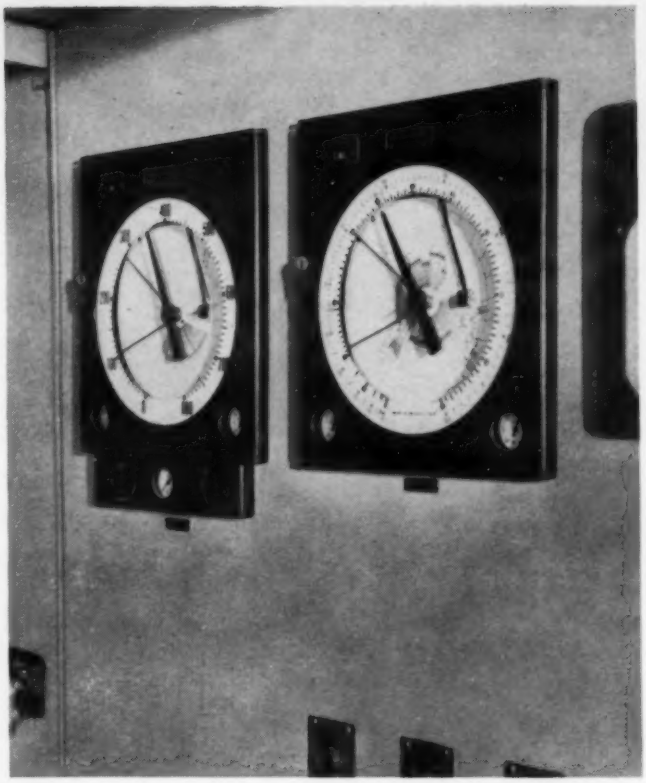


Figure 4 — Instruments shown indicate, record, and totalize fuel flow and also control firing rates.

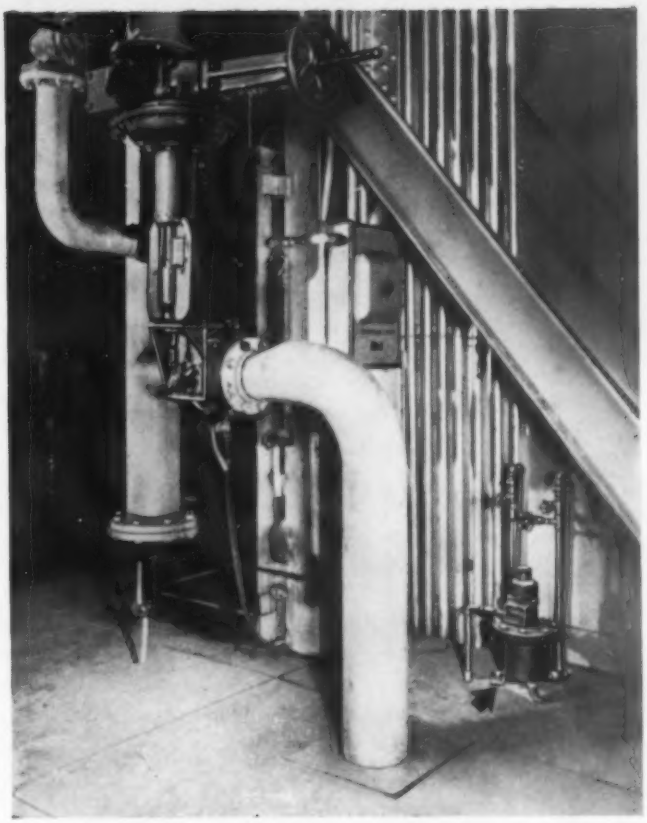


Figure 5 — Control valve will maintain any desired flow of either coke or natural gas.

which employs pneumatic summarization of coke oven gas and Bunker C oil. The two electronically operated flowmeters, in addition to the functions previously described, also transmit pneumatic signals directly porportional to the actual flowing volumes. These signals are pneumatically summarized by means of a relay which incorporates trimming means for difference in Btu value, and the result is transmitted to a large indicating gage, a control system and (on the extreme right) a recorder of total fuel input. The total fuel signal also establishes the set point for air flow, which is recorded and controlled in the same instrument. The ratio of air to total fuel flow is set to any desired value at the instrument, as well as incorporating an adjustable bias to compensate for air infiltration. The steam volume control can be ratioed to oil volume by means of the pneumatic signal from the oil meter, again with a similar bias for minimum oil rates.

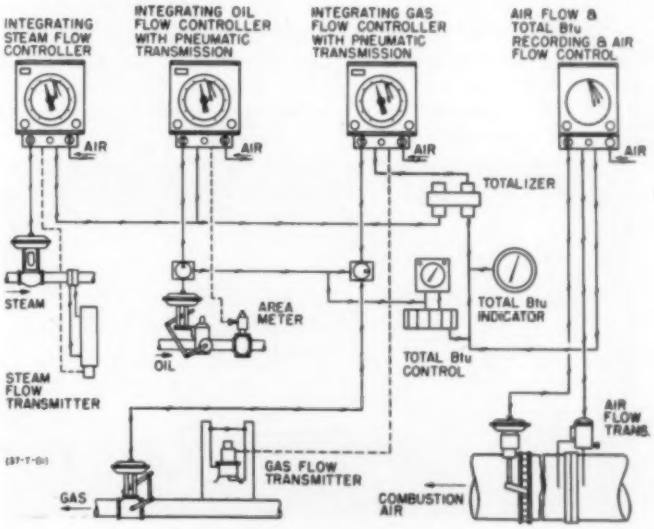
In operation, this system can provide either direct control of both liquid and gas fuels, or either fuel can be set at a desired value—automatically controlling the other fuel to supply any total requirement as set by a single loading station. Modification of the system as shown can incorporate these additional functions:

1. Minimum volume of liquid fuel.
2. Adjustable ratio between fuels.
3. Cut-off gas below a preset value.
4. Use of coke oven gas based upon availability, either in sequence of furnaces, maximum usage or percentage reduction on all furnaces.

Another design of multiple fuel system, as installed on four three-zone, slab reheat furnaces, is illustrated in the block diagram of Figure 7. In this case the summation of fuel flows is accomplished electrically to secure greatest accuracy and sensitivity. The temperature requirement of the furnace establishes the total fuel requirement. Coke oven gas availability determines the quantity of that fuel which is burned, making up the balance with oil. Again, the system makes available by simple panel board switching, independent control of both fuels or automatic make up by either oil or gas. Extremely stable and rapid operation is being secured, by means of pneumatic control systems, with a range of fuel ratios exceeding ten to one in both directions. Typical temperature, total fuel, oil and gas related charts are shown in Figure 8, as taken from one zone of this installation.

The efficient control of direct fired recuperative soaking pits has introduced several modifications beyond

Figure 6 — Schematic diagram for modern multiple fuel system.



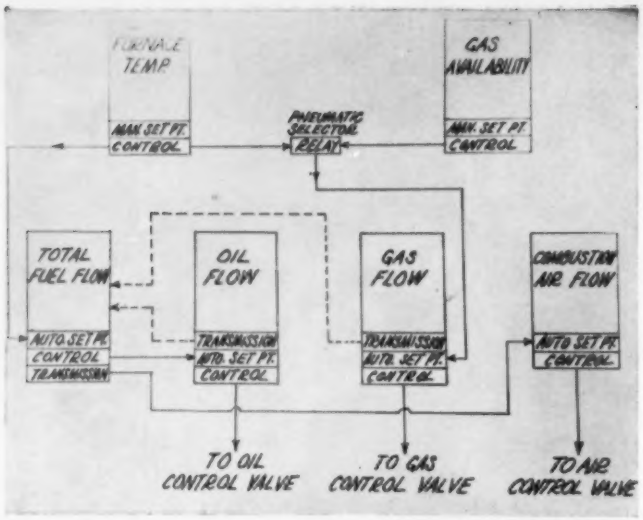


Figure 7 — This multiple fuel system is installed on a 3-zone, slab reheat furnace.

the conventional temperature, pressure, and fuel-air ratio systems. In order to utilize pit capacity to the fullest extent, the maximum possible heating rate should be used. This may be done without overheating the steel by a simplified form of programming. The temperature control set-point for the heating period is established at approximately 150 to 200 F above the desired rolling temperature. As the pit reaches this temperature, a timer is energized. At the expiration of the present time period, the temperature set-point is automatically lowered to the rolling temperature and the pit is permitted to "soak-out." A similar system, operating on either electrical of pneumatic principles, may be employed to lower pit temperatures during predetermined holding periods.

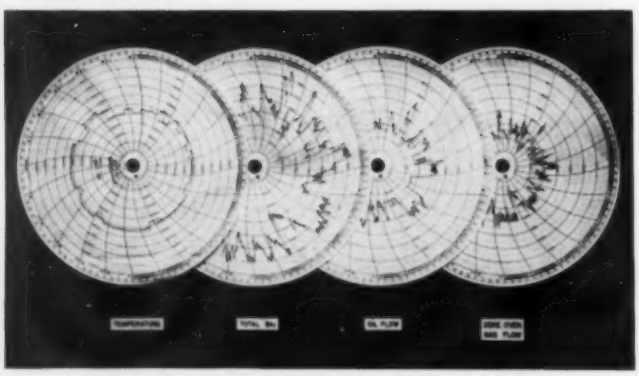
When ingot temperature is uniform, the fuel rate to the pit will have been reduced to an amount necessary to satisfy radiation losses. This frequently presents a problem of maintaining proper circulation for temperature distribution. When two fuels are used, a solution is provided by automatic equipment to control the ratio between the two fuels. During the heating period, a high ratio of coke oven gas to blast furnace gas may be used. However, during the soaking period, a lower ratio provides the high volume of gas desirable for circulation.

This problem has also been overcome by recirculating waste gases from the flues back through the pits. The flow of waste gas may be initiated and controlled automatically from the position of the main gas valve. Figure 9 illustrates such an arrangement. The electronic relay permits adjusting the relationship between main and waste gas valve travel.

When air volumes must be metered on the hot side of the recuperator due to design construction, it is necessary to compensate the flow measurement for these temperature changes. This has been successfully done by mechanically varying the fuel-air ratio with a control mechanism, operated from the air temperature measuring instrument.

Since the pit atmosphere must be regulated very closely to maintain a satisfactory scale condition, the most satisfactory future solution to this problem is undoubtedly to measure the amount of oxygen in the waste gas and trim the fuel-air ratio setting to hold a fixed oxygen concentration. A successful European installation has been operated with this control refinement.

Figure 8 — Typical recording charts are shown from the slab furnace.



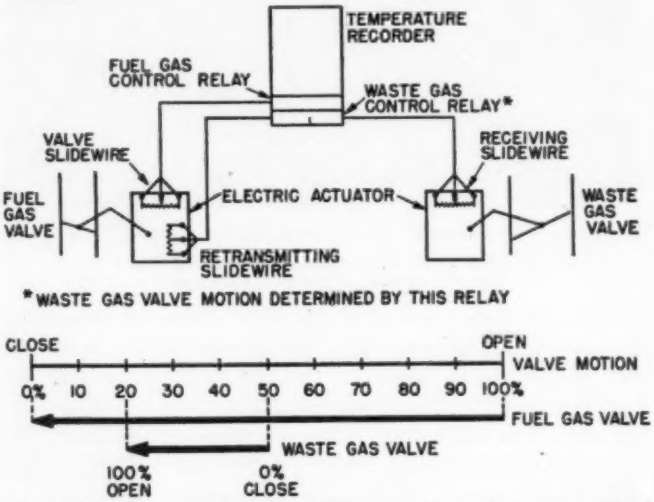


Figure 9 — Flow of waste gas from soaking pit is controlled from the main fuel gas valve.

MODERNIZING EXISTING FACILITIES

The modernization of existing facilities by the application of the instrumentation now available is a timely means of improving product quality, lowering fuel costs, and increasing capacity without major capitol expenditures for new construction.

The extensive application of controls to existing regenerative soaking pits is an outstanding example of what can be accomplished in this direction. These installations cover a wide range of conditions, from application to old pits without any structural improvements to partial rebuilding of them, by means of converting old four-hole into two-hole rows, the use of modern cover designs, forced draft, or addition of stacks for better draft and combustion conditions. In every case, the addition of temperature measuring means in the cover is a prerequisite to automatic operation. Figure 10 illustrates the installation of radiation elements to a modern design cover. This measurement in practically all cases, is used to control fuel rates by the two-position mode, i. e. firing at a preset rate until a maximum pit temperature is reached, then cutting off fuel and dampering the pit. When cover temperature drops approximately 50 F, full firing rate

Figure 10 — Radiation pyrometers have been installed on these pit covers.

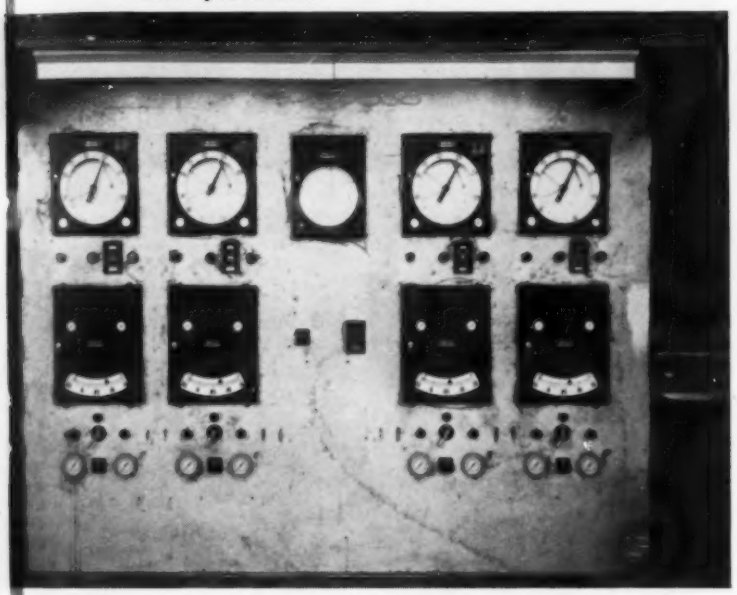


Figure 11 — Control of pit pressure may be applied to natural draft or to the inductor stacks.

is resumed, and may be interlocked with reversal action to prevent the possibility of repeated firing in only one direction. A control of pit pressure, as illustrated on the panel board of Figure 11, may be applied to natural draft—as in this case, where no structural changes were made on an old four-hole row—or applied to inductor stacks. Automatic reversal on a timed basis is always provided, and may incorporate a manual on automatic control of air volumes through damper position while on the firing cycle.

A summation of operating results from well over 100 pits in some ten different plants, with which the writer is most familiar, shows the following range of data, illustrated by the graph of Figure 12.

In every case, the uniformity of heating, and type of scale have been excellent. The washing of ingots is practically unknown, with resultant major improvement in bottom practice and up to 3 per cent better yield.

The heating time, in tons per hour, varies from about a standoff in comparison with previous practice to over 30 per cent improvement, with equivalent 3½-hr track time. However, where pit size has been enlarged by converting four holes to two, the total tonnage per month has been increased almost 50 per cent in spite of only a 20 per cent increase in available area.

The fuel practice, in Btu per ton, has shown a range from 15 per cent fuel saving where no other structural changes were made, to better than 30 per cent reduction where all possible design improvements were incorporated. As a typical example, where an entire shop had averaged 1,100,000 Btu, the controlled regenerative pits have run as low as 600,000 with monthly average running about 750,000 Btu. Pit life appears to be extended by at least 50 per cent. One installation after more than three years of service was still producing 90 per cent of original capacity by comparison to 65 to 70 per cent experience on uncontrolled pits. Checker life has been doubled.

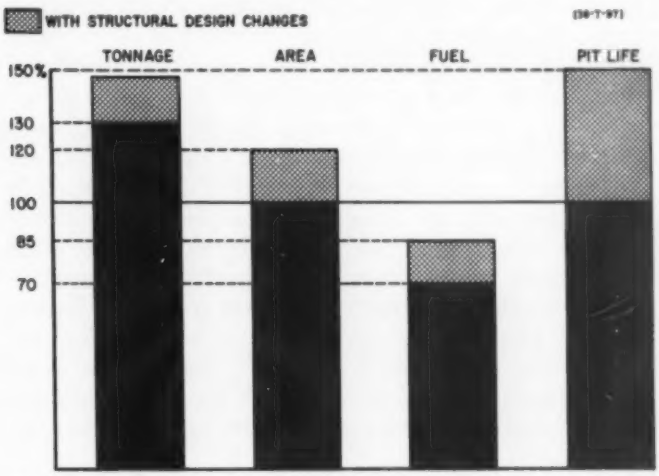


Figure 12 — Performance was improved by applying instrumentation to old regenerative pits.

INTERLOCKED OR CASCADE CONTROL SYSTEMS FOR INTERRUPTABLE PROCESSES

The steel industry progressively is extending its manufacturing techniques in the direction of continuous processes and higher speeds. Unfortunately, many of these operations are subject to interruptions from such things as roll changes, stitching and welding failures, or different product specifications. This places an additional load upon personnel and control equipment to rapidly establish new operating conditions in order to protect products or equipment during these unpredictable periods.

The manufacturers of electrical driving equipment have accomplished much in their ability to handle automatic and synchronized acceleration and deceleration. Similar improvements are possible in the field of industrial instrumentation by the use of modern servomechanism principles.

One of the outstanding problems has been the regulation of continuous reheating furnaces during and following mill delays. The heater has been called upon to rapidly outguess the mill requirements, with an additional complication of operating furnaces at a high heat head in order to secure the desired tonnage rates.

Some new approaches to the solution of this problem are illustrated schematically in Figure 13, covering an experimental installation now being placed in operation. Since a measurement of furnace temperature, rather than actual steel temperature, is the only universally applicable method of measurement in furnaces of this design, a variable gradient must exist between

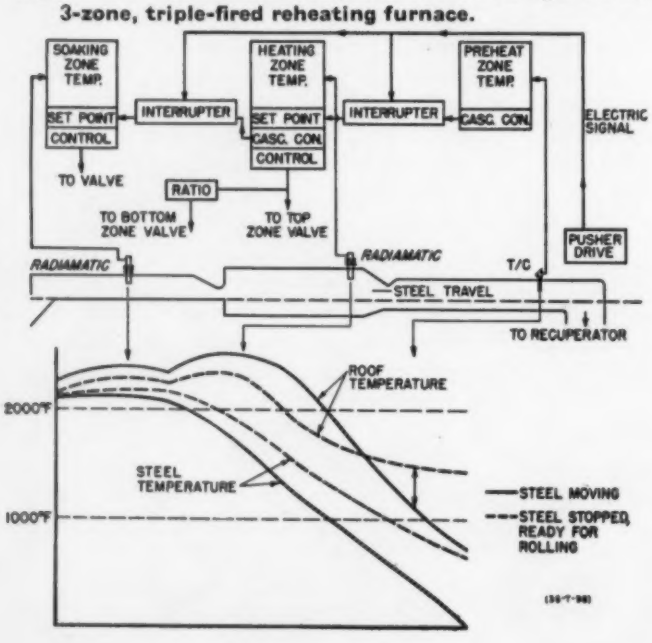
furnace and steel temperatures. This gradient is a function of both charging rate and time required to re-establish equilibrium over the entire length of the furnace in order to discharge steel at the required temperatures.

Two fundamental principles are employed in this control system to automatically set the required working heat head in each zone of the furnace. The first is designed to make use of temperature measurements in the charging or preheating end of the furnace, as an indication of heat absorption by the steel. As this temperature rises, the set point of furnace temperatures in the heating zone (or zones) is automatically lowered. Secondly, in order to avoid overheating of steel, which is at least partially soaked out during delays or slower charging, the rate at which furnace temperatures are raised is also made a function of the charging rate. Further cascading sequence in the automatic establishment of soaking zone set point is dependent upon the attainment of temperature stabilization in the heating zone. It is obvious that furnace temperature limits, both at or below desired rolling temperature on the low side, and not in excess of refractory limitations on the high side, must be incorporated for protection. An additional desirable function is the automatic resetting of fuel air ratios, assuring minimum scaling conditions under a wide range of retention time in the furnace.

The potentialities for the steel industry of continuous casting techniques also demand extension of modern high speed and cascaded control methods to rapidly stabilize the number of variables which affect the operation of this process. Figure 14 shows the basic structural components of such a production unit which is now made available by one equipment manufacturer.

It is obvious that metal level as maintained in the mold is a most important factor. The accurate measurement of this condition has employed x-ray, radioactive materials and radiation principles by operators in this country and abroad. The maintenance of level is dependent upon the speed of pinch rolls, and flow

Figure 13 — Interlocked temperature control system for 3-zone, triple-fired reheating furnace.



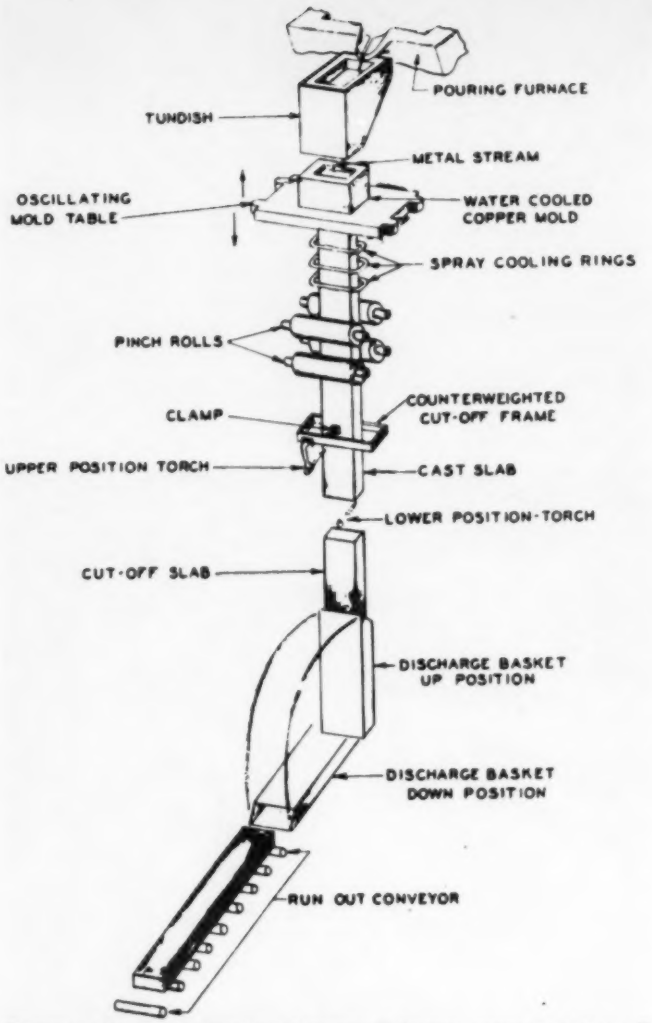


Figure 14 — Schematic diagram shows components of continuous steel casting machine.

or weight of molten metal as delivered from tundish and/or pouring ladle. This flow, as well as cooling requirements is a function of metal temperature. The physical and metallurgical requirements of the final product are affected by the flow rate of coolant water, as well as its temperature and sequence of distribution. It is entirely possible with modern control methods, to properly interlock and sequence all of these variables into an integrated system of automatic regulation.

SUMMARY

In conclusion, we find that the specific desirable characteristics for steel processing operations continue to be incorporated in designs produced by the instrument manufacturing industry. The media used by the steel industry to accomplish automatic regulation has been undergoing a gradual transition. At present, it can be observed that a combination of electric, pneumatic or hydraulic operation frequently provides the simplest overall systems. The modernization of fuel practices and existing furnace facilities can be economically accomplished with the assistance of instruments and controls. To take full advantage of improved processing methods, a closer coordination between plant operators, designers of equipment and instrument engineers in the development stages should result in more rapid progress throughout this expanding basic industry.

by W. J. McCLUNG
Vice President Steel Plant Operations
Bethlehem Pacific Coast Steel Corporation
San Francisco, Calif.

YOUR ASSOCIATION

. . . . from a talk given at dinner at the AISE Western Meeting, in Los Angeles, California, February 20, 21 and 22, 1956 . . . .

▲ IT is our purpose to speak of the Association of Iron and Steel Engineers, particularly as "Your Association," and how it may affect and influence the development of the steel industry in the West.

We feel certain that most of you realize how an expanding population can be a most dynamic factor in the development of an area. People need homes, food, clothing, autos, schools—just to mention a few of the necessities required. Therefore, this part of the United States is destined to make tremendous strides in the manufacture of thousands of products necessary for the pleasures and welfare of a rapidly growing population and the necessities of a fast expanding economy.

In addition to industrial growth based on population, there is also an increased industrial expansion based on manufacturing products in the West and shipping them to other parts of the United States. In this respect, the West has achieved recognition as an important supplier of aircraft and its components, electronic equipment, furniture, heating and plumbing fixtures, construction materials and innumerable other items.

Should there be any questions as to the magnitude of this growth, we are sure reference to several statistics will dispel such questions as may arise.

We will mention but four sets of figures. In 1940, the population of the eleven Western States was 13,931,000. Today, it is 23,600,000. In 1940, the ingot production capacity of these same states was 2,165,720 tons. Today, it is 7,131,470 tons. We will not mention the percentage increase in either case. Suffice to say, the percentages are eye-openers. Undoubtedly, we have been too conservative in our thoughts on Western growth.

This kind of development or expansion requires engineers (or shall we use the better term, "technicians"), not only to create and enlarge these vital production units, but to operate them. These technicians are the supervisors of the present and future. The steel industry does not expect the young technicians to stay in elementary positions, but rather expects that they will grow into positions of leadership. They must learn the art of creative imagination and ingenuity which will enable them to combine raw materials, equipment, manpower and procedures into finished products at increased production rates and at lower costs.

In such a development of technical talent, "Your Association" can play a tremendous part. The shortage of trained technicians in present production facilities is great. Production units can be expanded, and improvements made in a relatively short period, but it takes a much longer period of time to train and develop technicians properly, unless we endeavor to shorten the process.

Most of us are aware of the present shortage of technicians. It has been estimated that there is a shortage of at least 10,000 engineers annually, and that the supply and demand will not be in balance before 1964. We all concur that the technician has been an important factor in the growth of the steel industry, and that more of them, not less, will be required if present plans for expanding the industry are realized. Therefore, it would be logical to expedite the industrial training of the junior technician in order that any latent talent will be brought forth to the greatest degree.

Most of the young technicians in our industry have the ambition to develop to responsible positions, but

we must be aware of the pitfalls and disappointments that they may encounter, if they are not properly guided. This can be a very critical period in a young technician's life, as he needs help in the broad training required to assume the responsibilities necessary for promotion to supervisory positions.

"Your Association," by developing programs to assist the training of the junior technicians in order to develop their maximum potentialities, can reduce effectively the critical shortage of engineering and scientific manpower. If provided such opportunities, the budding technician can develop at a maximum rate and will be able to meet supervisory problems as they are encountered. It is important that your Association continue to emphasize those activities of the industry that are of vital concern to us, such as open hearth and electric furnace operations, rolling mill techniques and the successful solution of troublesome maintenance problems.

We quote from the Constitution of the Association of Iron and Steel Engineers: "The object of this Association shall be the advancement of the technical and engineering phases of the production and processing of iron and steel." To anyone who has attended the technical sessions in your meetings, there can be no doubt that the aims of the association are being furthered.

It has been our pleasure on several occasions to sit in on your local meetings and to participate in one of the regional meetings. The excellent quality of the papers presented and the enthusiastic discussion which followed are a true indication of the serious thinking which your programming receives. The quality of these presentations also indicates the effort and thought which their authors put into them. We know from experience that an organization such as yours to be strong, healthy and useful must have leaders who work wholeheartedly and give generously of their time and thinking. Our personal observations cause us to believe "Your Association" is well fortified in this respect.

You have local meetings either on a monthly or bimonthly basis. The planning for such meetings must be as complete as possible to obtain the best results. Your committees on selection of speakers and subjects should always be several meetings ahead of themselves. This provides time for more thorough development of the subject prior to presentation. No one person knows all the answers on any subject. There are specialists, of course. A man gives a paper on a particular subject or phase of our business. Following his presentation, the discussion period invariably indicates that others have just as keen an insight into the subject as does the author. Sometimes the author gets stumped in the questioning of his remarks. So we say, allow plenty of time for proper and complete preparation.

The subjects chosen should be of mutual interest to as many of the group as possible. This is not too difficult an accomplishment, for in our business there is considerable over-lap between the many divisions of effort. Likewise, there usually exist several different ways of arriving at the proper solution. This is, of course, the result of individual thinking and practice as applied to the common problem. No two steel plants are identical; however, in many cases the problems encountered at different plants are identical. So, usually what is good for one is of similar value to another. Here again, the degree of value depends on the individual thinking and practices employed at a given location. So again, we suggest that your programming always be done well in advance to permit the best possible presentations. In many cases, proper approvals must be obtained prior to presentation. Significant time must be allowed for this necessity.

"Your Association," in planning for the very splendid regional meetings, such as this one, has an even greater responsibility in allowing for proper programming. The regional meetings are a bigger show. They are much broader in scope not only in subject matter, but also in attendance. We noted with interest from the 1956 western meeting program that during the course of the technical sessions, a total of twenty-seven men were engaged either as session chairmen or as speakers. Also, of these twenty-seven men, sixteen are located in the West, and eleven are situated in eastern locations. In total, they represent six different western operations and nine eastern companies. This seems to be a reasonable spread of talent, and certainly indicates a desire on the part of your program committee to present a well-rounded schedule. While not present at all of these technical sessions, we did observe that the discussion periods brought many more into active participation.

This brings us to another value of "Your Association" in aiding the development of our industry in the West. Exchange of ideas is best accomplished, of course, when the various ideas are brought into the open or to the attention of others. There are very few real secrets in this business. However, we all run into difficult problems now and then, and quite often others have been up against the same or similar situations before us. Many of these have been solved more easily locally by reason of the knowledge liberated by others who have had the question before them. Your local chapter meetings present splendid opportunities for exchange of thoughts. We are familiar with both the Bay Area section and the Los Angeles section, and know from personal experience that the boys really do a lot of talking prior to and after the programmed speaker. These gatherings provided splendid opportunities for the gentlemen in attendance to open up on their experiences.

Prior to the establishment of the Association of Iron and Steel Engineers here in the West, local managements were not very well acquainted with their similarly interested neighbors. We are convinced this situation has changed since the Association's first western regional meeting two years ago in Los Angeles. Since then, the interest has spread like wildfire, and the way our own people now talk of others by their first name is really significant. Through the medium which you provide, acquaintances are made and broadened, and operators are aided in their own efforts by the realization that so-and-so at such-and-such plant has something in common. By one means or another the two will get together either by telephone or by visit,

and, as a result, a better understanding of a problem will be had. The coming of "Your Association" to this area is responsible for much of this new cooperation between similarly interested parties.

Along similar lines, the contacts made with associate members can be of mutual benefit to the industry and the supplier of essential equipment. Such contacts provide for further exchange of technical and operating information on an informal basis which can be mutually attractive and beneficial to all concerned. Very often, participation in a round table discussion by active and associate members from various companies will bring forth valuable interchange of information which is of mutual advantage to both. There is no doubt that such discussions go far in advancing the technical and engineering phases of the industry.

It so happens that those of you who make the plant tour tomorrow will be visiting a plant of tremendous interest to several of us. Here again, your committee in charge has made it possible for you to visit another steel plant operation. No doubt many of you have never visited the Los Angeles Plant of Bethlehem Pacific, and we are pleased to open the gates to you. You will find it interesting. Our reason for mentioning the plant tour is to point out another value of your organization. These visits are broadening to the participants and to plant personnel as well. A two-fold good results. In what better way can so many people gain an understanding and appreciation of an operation in such a short time? Also, were it not for this and other regional meetings, such opportunities to visit other plants might not be presented.

We would not like to close without mentioning the excellent publication put out by "Your Association," *The Iron And Steel Engineer*. This monthly engineering journal contains many excellent technical papers on steel plant design, construction, operation and maintenance. Also, the publication of the discussions that occur at "Your Association" meetings provides interesting comments and viewpoints concerning the contents of the papers which are of considerable help in evaluating the subject covered. We all know the value of the printed word, and here again is an excellent opportunity to assist the up-coming technician.

We would like to point out one other objective that should concern all of you, and refer to active participation in securing new members. Each and every one of you should be an individual membership committee to procure at least one additional member. By so doing, "Your Association" will become better known and will acquire the benefits of active growth which brings forth new enthusiasm and fresh ideas.

In concluding these remarks this evening, we want to assure you that we have found the activities of "Your Association" to be most interesting and to exert a strong influence on the technical thinking of the steel industry. An organization with purposes such as yours will certainly be successful in achieving your avowed goal of advancing the technical and engineering phases of the industry.

REPORT DESCRIBES METHOD FOR OBTAINING MANGANESE FROM SLAG

▲ A method that might be used in an emergency to recover urgently needed manganese from open-hearth steel-furnace slags is described in a Bureau of Mines report.

Called a lime-clinkering carbonate-leaching process, the method was tested by the Bureau in cooperation with the American Iron and Steel Institute as part of a program to increase the nation's self-sufficiency in manganese, an essential element in making steel.

The open-hearth slags discharged yearly as waste from domestic steel plants contain almost as much manganese as the steel industry consumes annually. Therefore, development of a method for recovering a substantial portion of this manganese would strengthen the United States' position in a highly strategic commodity.

After intensive laboratory studies, made at the Bureau's College Park, Md., station and described in an earlier report, the Bureau decided to test the process in a pilot plant.

Pilot-scale tests showed that the process is technically feasible and, in an emergency, might provide substantial quantities of manganese. Although the method is costly, the report says it yields a high-quality product that would demand a premium price on today's market for making steel and special alloys.

Results of the tests are given in detail in the report, which contains complete descriptions of the process and the pilot plant. Several tables and illustrations supplement the text.

A copy of Report of Investigations 5142, "Manganese from Steel-Plant Slags by a Lime-Clinkering and Carbonate-Leaching Process: Part II. Pilot-Plant Development," can be obtained from the Bureau of Mines, Publications Distribution Section, 4800 Forbes Street, Pittsburgh 13, Pa. Part I of the report, subtitled "Laboratory Development" and published as Report of Investigations 5124, can be obtained from the same address. The report or reports desired should be identified by number and title.

STAINLESS STEEL PRODUCTION BREAKS ALL RECORDS

▲ PRODUCTION of stainless and heat resisting steels in 1955 hit an all-time high with an increase of more than 40 per cent over the previous year, according to preliminary figures released recently by American Iron and Steel Institute. Production for the year was 1,191,177 net ingot tons, compared to 852,021 net tons for 1954.

According to Mr. Richard E. Paret, of American Iron and Steel Institute, stainless steel has shown a remarkable advance as compared to other metals. The 40 per cent increase in stainless production during 1955 is even greater than the overall steel increase of approximately 36 per cent, which in turn leads other significant metal production advances.

This record-breaking increase indicates not only a general rise in business activity, but also an accelerating demand for stainless steel for industrial and consumer products. This demand has been caused by a rising recognition of stainless steel's ability to give high performance and economy in industrial applications, and by the consuming public, which likes stainless steel's combination of glamour and practicality.

Over 30 standard AISI stainless steel types as well as two heat resisting types, are included in these figures. A total of 648,161 net tons of chromium-nickel 300 series stainless, including the recently introduced chromium-nickel-manganese 200 series, were produced. The production of chromium stainless steel, the 400 series, amounted to 518,472 tons.

The chromium types, or the AISI type 400 series, show a general increase in output above the average 40 per cent for all types. Type 430 shows an increase over the previous year of 56 per cent; type 416, 50 per cent; and 410, 51 per cent. Until the figures of consumption by specific markets are available, one can only speculate on the reasons for this, but there has been a tremendous use of type 430 by the automotive industry. Moreover, it is possible that industry confidence in the 400 series to perform well in many varied applications is still increasing.

During the Korean War, industry turned to the chromium types because of the nickel allocations. Experience indicated that the chromium types need not be considered substitutes for chromium-nickel types, but instead are highly usable materials and preferable for many uses.

It was also pointed out that AISI type 301 showed a 59 per cent increase in production over the previous year. Type 301 is capable of being cold worked to exceedingly high strength. Thus, it is extensively used in the transportation industry, where light-weight, high strength construction is required and where good corrosion resistance means economy through long operating life.

The increase in production of type 304 amounted to approximately 24 per cent, a somewhat lower figure than the average. On the other hand type 316 has shown an increase of 57 per cent, which is higher than the average. This may be partially explained by the increasingly severe demands placed upon equipment by the chemical and other industries. Type 316 has an austenitic structure which contains 16 to 18 per cent chromium, 10 to 14 per cent nickel and 2 to 3 per cent molybdenum. It has an especially high resistance to certain acids and halogen salts, and is used extensively in chemical equipment, pulp and paper and textile processing.

Major changes in stainless steel designations are the result of improved industry practices and elimination of certain government controls, assuring users of even greater uniformity and dependability from these steels. Producers have been able to work to closer alloy limits, particularly on carbon. As a result the maximum permissible carbon content has been lowered for six grades: 301, 302, 302B, 316, 317, and 446. Low carbon content is required in most types for maximum resistance to corrosion, while higher carbon content is employed for increased hardness, as in cutlery grades.

Introduced during the year, the new low-nickel, chromium-manganese stainless steels, 201 and 202, were received with a great deal of interest on the part of industry.

Figure 1 — Total production of stainless and heat resisting steels is given for the years 1951 through 1955.

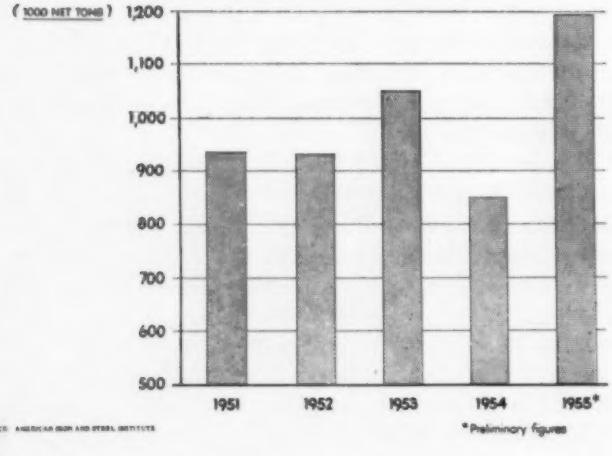
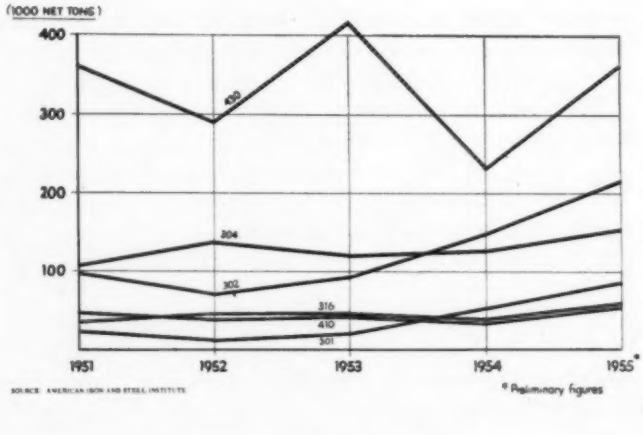


Figure 2 — Stainless production by AISI types shows varied fluctuations from year to year.



Four Open Hearth Furnaces designed by Rust for Lone Star Steel Company's modern steel mill at Lone Star, Texas

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in design and construction of

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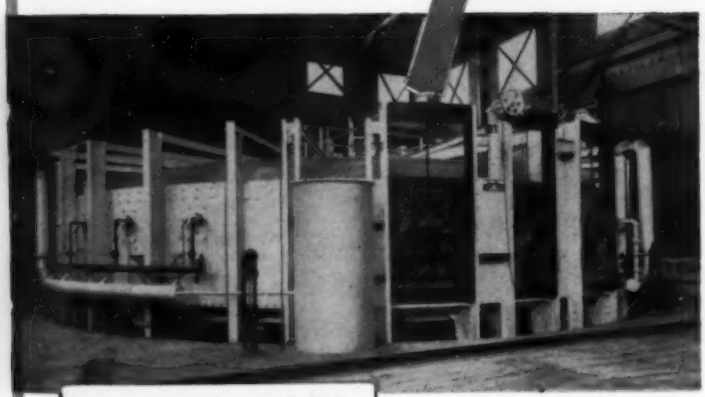

Rotary Hearth Furnace built by Rust for a Pennsylvania plant

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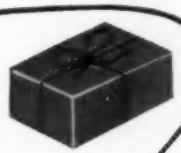

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Billet Cutting Is Made Easy

By V. E. LYSAGHT

American Chain & Cable Co., Inc.

Bridgeport, Conn.

▲ THE increasing demand for stronger and tougher steels and metal alloys by industry, has increased the problem of cutting them into assorted sizes and shapes for individual requirements. The challenge has fostered numerous types of metal cutting devices, some more efficient, some more expensive, some sturdier than others. Abrasive cut-off machines have kept pace with these demands through continuous improvement in operating techniques and in the cutting qualities of the abrasive wheel.

For severing their various steels and alloys, the harder the better, Crucible Steel's Park Works has installed two Campbell Model 480 Cutamatic wet cutting machines, capable of cutting 8 by 8-in. billets and two Model 406 Cutamatic abrasive cut-off units, capable of cutting up to 6 in. rounds, and modified Campbell model 213, capable of cutting rounds up to 2 in. in diameter. Of these new units, the models 480 and 406 are referred to as oscillating machines because the cutting wheel oscillates or rocks across the work during the cutting wheel feed. The latter unit is a chopper type as the cutting wheel merely plunges downward through the work by hydraulic control without the oscillating motion.

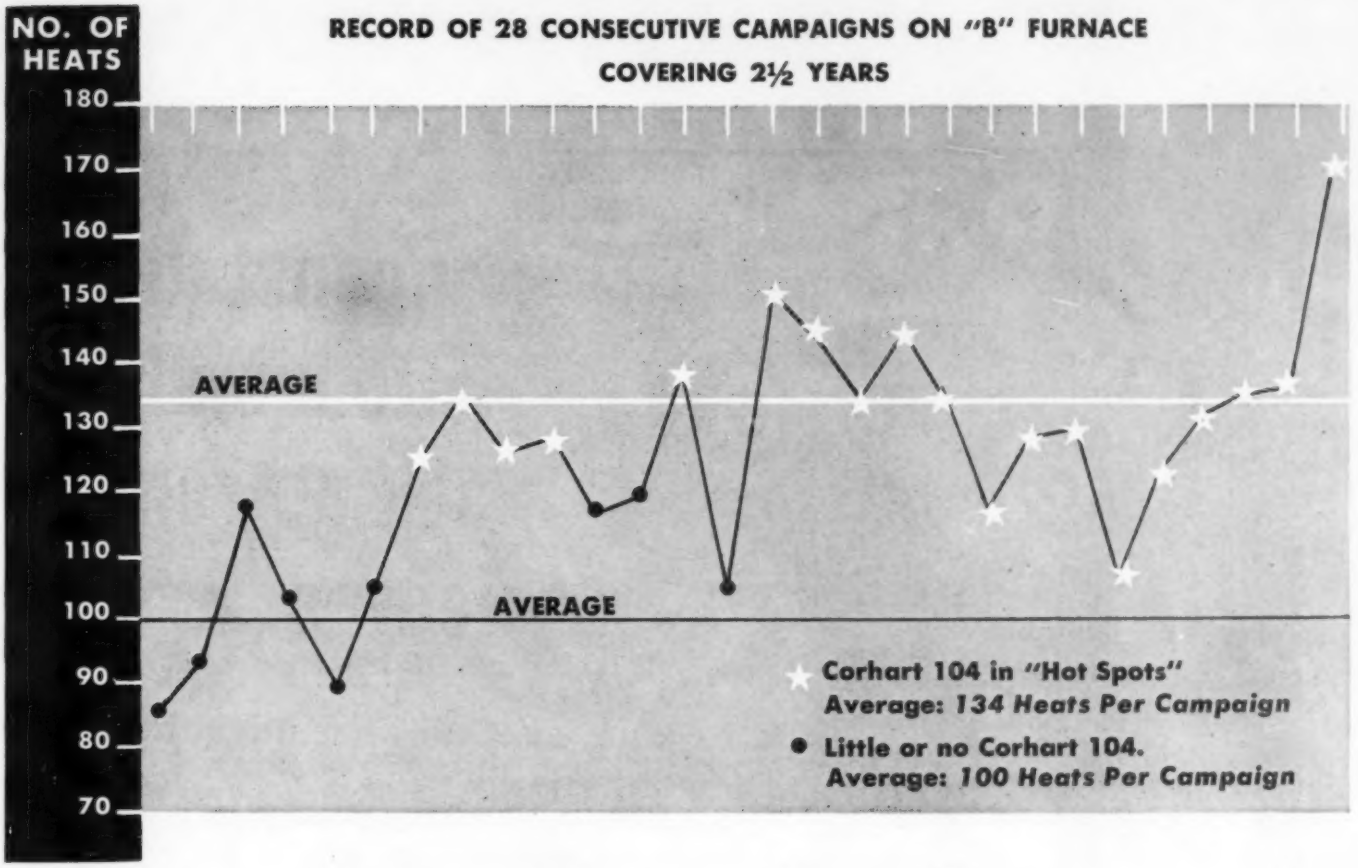
With the new machines, production is running at about 155 billets per machine, per shift.

In the Cutamatic, as the oscillating machine is named, the oscillating motion across the work is variable from 0 to approximately 4 in., and is created by a 56-rpm motor and an eccentric. The spindle of this unit is driven through multiple vee belts from a 25-hp motor. Coolant, usually soluble oil and water, is pumped from a portable coolant tank by a pump at the rate of 33 gpm into a water box which is designed for the most efficient cooling of wheel and work.

As the cut-off wheel is fed down hydraulically, it passes between the adjustable plates in the water box and carries the coolant into the cut. Therefore, with proper adjustment, there is no burning or distortion of the metal being cut. The abrasive wheel of the Cutamatic is of the rubber bonded type, made by The Allison Company, Bridgeport, Conn., and is 26 in. in diameter, is $\frac{5}{32}$ in. thick and has a 1 in. spindle hole. The wheel is held between 5 in. diameter flanges equipped with three drive pins, which engage in driving holes provided in the wheels and is said to eliminate the need for blotters between flanges and wheel. This provides a positive drive and eliminates the danger of wheel slippage and possible damage to the spindle. Most of these machines operate at a spindle speed of 7000 to 7500 sfpm, but can be varied by changing pulleys in the case of certain types of alloys such as titanium.

Figure 1 — Only one operator is needed to keep billets moving from the delivery table into the abrasive cut-off machine at the Crucible Steel Co. plant in Pittsburgh. In test cutting, the Campbell machine has cut the 5 x 5 in. section in 95 seconds of actual wheel contact time.

The two model 480 Cutamatics were installed in the billet department and require only one operator per shift. Yet, they adequately keep up with present production requirements. The first unit was delivered to the Park Works as a standard machine. After installation, Crucible engineers designed and built the feed-in and run-out machanism for handling the 4 by 4 in. and 5 by 5 in. billets. The second 480 was supplied by the Campbell Machine Division with certain modifications to reduce handling and operating time. Again, Park Work engineers improved the design of the feeding mechanisms by adding further refinements to the work handling equipment. The second of these machines will be described in detail. Flow cycle of the material received from Midland is very simplified in that the crane crew spends most of the shift unloading and stockpiling the billets shipped to the Park Works. In order to load the cut-off machine, a crane picks up 6 to 8 billets of 5 by 5-in. stock, or 8 to 10 billets of 4 by 4-in. stock with an electromagnet and places the lengthy pieces on the storage tables. About three minutes of time is required for the crane to stock the Campbell unit with 15 pieces of 5 by 5's or 20 pieces of 4 by 4's. These billets will keep the machine in operation for 4 to 5 hours.



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THE graph above tells the story! It shows that when little or no Corhart 104 Electrocast refractory was used, this sixty-ton electric furnace averaged 100 heats per campaign, for nine campaigns.

When Corhart 104 was used to fortify "Hot Spots" in the sidewalls, the average jumped to 134, for nineteen campaigns!

Chances are that small amounts of Corhart 104 could help "balance" your electric furnaces, too—*could help you get more heats per campaign.*

Let us tell you the whole story on Corhart 104 — the new magnesite-chrome refractory which is electrically melted at 4400° F., and then poured into its final shape. Write direct to Corhart Refractories Co., *Incorporated,* 1646 West Lee Street, Louisville 10, Kentucky, U.S.A. Telephone—CYpress 4471.

QUALITY ECONOMY ENDURANCE

CORHART 104 ELECTROCAST REFRACTORY

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Heppenstall's custom-built back-up roll sleeves...

work to your over-all cost advantage

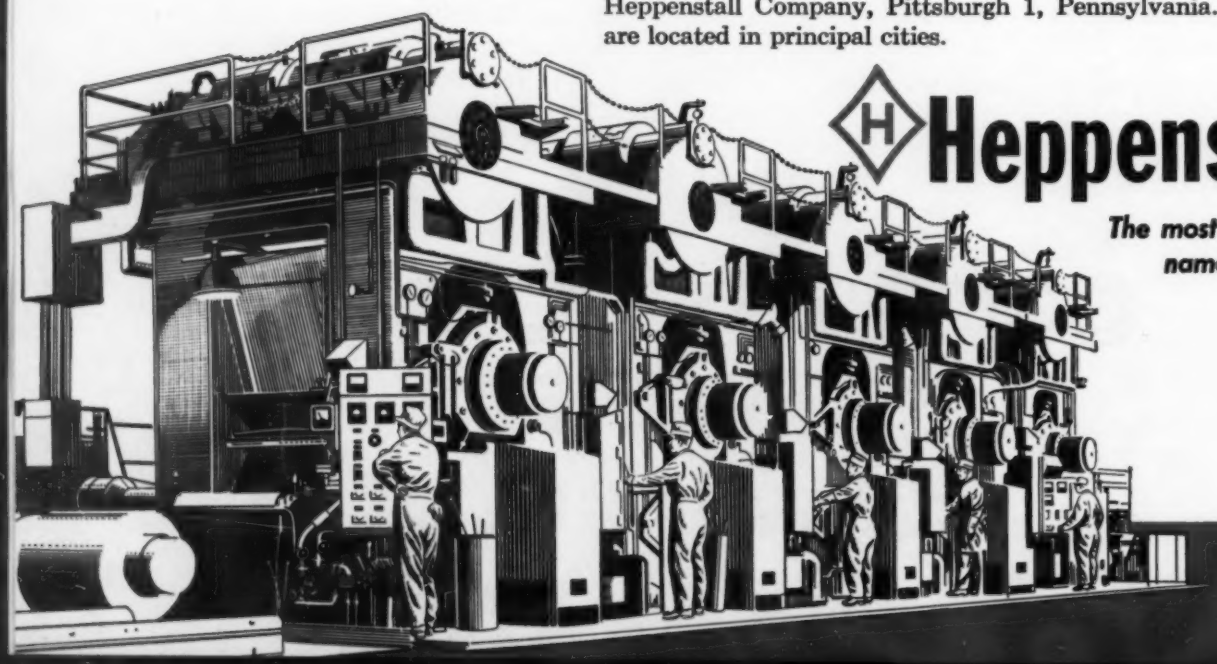
Heppenstall Back-Up Roll Sleeves enable you to roll record tonnages . . . decrease downtime . . . and effect over-all cost reduction. They give longer working life in today's high-speed mills because their up-to-the-minute design permits utilization of more effective forging and heat treating operations in their production. Each sleeve's working surface is *tempered to meet your exact hardness specification.*

These mandrel-forged sleeves—made from highest quality Heppenstall-produced alloy steel—are worked thoroughly under modern hydraulic presses to produce a finished product having both maximum density and grain refinement. In addition, they offer you exactness of fit and greater resistance to cracking and spalling during high-speed rolling.

All Heppenstall sleeves are fitted to extremely close tolerances which prevent circumferential slippage. Longitudinal movement is also eliminated because they are further locked in place by both a shoulder and Heppenstall's own patented locking ring.

Heppenstall also produces forged arbors . . . has facilities to grind both arbors and sleeves for perfect shrink-fitting.

For additional information and technical assistance, contact Heppenstall Company, Pittsburgh 1, Pennsylvania. Sales offices are located in principal cities.



Heppenstall

The most dependable name in forgings

These billets are pushed by two pawls attached to two motor-driven lead screws onto the feed-in table. Rolls, chain-and-sprocket driven, then feed the billets into the cut-off machine. At his station, the operator then cuts off the first 2½ to 4 in., due to the "fishtail" from hot shearing and discards this into the scrap pan located at the cut-off side of the machine. The waste may eventually be eliminated since one end of every cut has a smooth abrasive-cut finish. This cut billet is then driven against a combination work stop and measuring gage, adjusted to proper length beforehand by a motor-driven lead screw. Once the gage is set, it can be swung down, or back out of the way through the action of a controlled air cylinder.

To initiate the cycle and start the Campbell unit, the operator simply turns the control handle which automatically clamps the sides of the billet by means of a special hydraulically-operated clamp arrangement at the feed-in side of the abrasive wheel. Then, turning this control handle to the next position, it starts the wheel feeding mechanism downward by action of a hydraulic cylinder located in the front of the machine. Coolant can be turned on or off by hand at the inlet in front of the abrasive wheel guard, but is generally kept on during the constant cutting operation. After the wheel passes through the billet, it contacts a carbide-tipped button, which energizes a four-way solenoid operated valve, thus raising the cutting wheel clear of the work. A wheel measuring device on the feed cylinder automatically adjusts the wheel for wear, and maintains proper wheel travel for the size of billet being cut or severed.

The cut billets are then carried down on a chain-and-sprocket driven roll run-out table to a kick-off. When an individual billet hits a stop, an air-release valve opens and tips a table, and the cut piece slides into a stock pan. A feature of this arrangement is a safety control which prevents the bar from being kicked off in case the operator or crane-follower is arranging bars in the stock pan.

The feed-out table of the newest model 480 is equipped with two kick-off tables in order to eliminate loss of time in unloading the filled stock pan. Approximately 25 minutes of crane time is required every six hours in order to empty the stock pans. These cut-off pieces may vary from 18 to 45 in. in length, depending on the mill application.

Figure 2 — Final step in abrasive cutting operation shows cut billet (26 in. long) traveling down feed-out table to waiting bin. The billets, shortened for easier handling, will eventually be reduced in size on smaller mills.

In test cutting performed at the Campbell Division before installation, this unit has severed 5 by 5 in. billets in 95 seconds of wheel contact time.

As an example of machine and wheel performance at the Park Works, a 5 by 5 by 110-in. billet (actually 5 1/32 in. round cornered) and weighing approximately 770 lb is to be cut into four pieces about 26 in. long, weighing about 179 lb each. The normal operating cycle at Park is 2½ to 3 minutes wheel contact time, and ½ minute for the remainder of the cycle for feed-in and feed-out.

The operator consumes about 30 minutes at the end of the shift for cleaning the machine; 10 minutes at the start of the shift to check the schedule sheet and the settings of the gage stop; 20 to 25 minutes throughout the shift to change 4 to 5 wheels, and 20 minutes for lunch. Operating time of the machine in an 8-hr shift is therefore only 6 hr and 35 minutes.

Park obtains about 124 good cut-off pieces per shift per machine. Since it requires five cuts per billet to obtain four good pieces due to the scrap ends, it means that 155 or more cuts are obtained from four to five abrasive wheels. When these wheels are worn down to about 18 in. in diameter, they are sent to the model 406 Cutamatic machines where they are utilized until worn down to 12 to 13 in. diameter. From these units, the wheels are then used by the model 213 machine and are scrapped after being reduced to 7 or 8 in. in diameter.

On 4 by 4 in. (4½ in. round cornered billets) an average shift of 6 hr-35 minute operating time, the machine produces 140 pieces or 175 cuts for four to five abrasive wheels worn down to 17 to 18 in. They have, however, on this size, obtained as many as 50 or more cuts per wheel on some alloys.

The high quality of the cut obtained on the billets, that is the square ends and freedom from burr, is important in the subsequent operations on the hollow drill steel.

With the continuous development by the steel industry of stronger and tougher steels and their alloys which become more difficult to cut with conventional equipment, abrasive cut-off equipment will undoubtedly be in demand and prove to be the most logical and economical method of cutting.

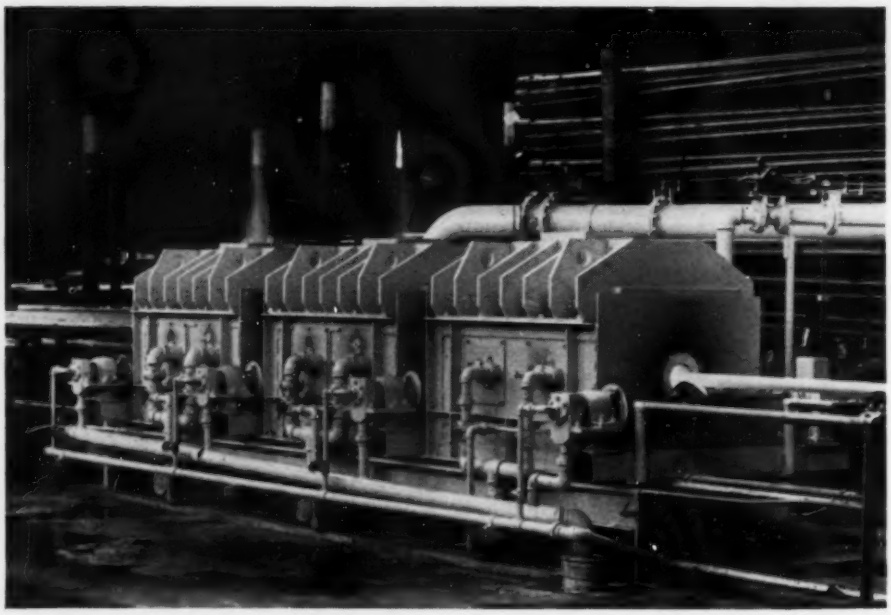


Figure 2 — Each of these three furnaces for a continuous mechanized normalizing line for seamless tubing are four feet long and have four gas burners. Burners for two heating furnaces are of 1,000,000 Btu capacity and those in the third are of 750,000 Btu capacity.

Spang-Chalfant Installs Automatic Mechanized Heat-Treating Equipment

▲ FULLY automatic mechanized heat-treating equipment has been designed and built at low cost by the combustion engineering department of The National Supply Company in the Spang-Chalfant Division plant in Ambridge, Pa. It is used for continuous normalizing of small sizes of oil well tubing.

The equipment includes three small furnaces, instrumentation for heat control by automatic regulation of valves in gas lines to burners, and automatic, variable-speed conveyors for handling the tubing between charging table and cooling table. Approximately 1000 tons of tubing per month are normalized on a 20-turn per week schedule. One man operates the equipment.

A feature of equipment design is the minimum use of high alloy steel in the conveyors. This was achieved by placing all conveyor rollers outside of the three furnaces. Furnace conveyors consist of four water-cooled high-alloy rollers between and at the entrance and exit ends of the three furnaces. Inlet and outlet conveyor tables each have seven powered rollers.

By using the company's own engineering staff and recovering handling equipment formerly used in pipe threading operations for conveyors and pipe racks, the total cost was held to a minimum. The new equipment was installed to meet increasing demand for N-80 grade oil well tubing which is made of steel having a yield strength of 80,000 psi.

Figure 1 — New continuous mechanized normalizing equipment for oil well tubing has pipe handling, conveyor speed, and furnace temperatures under instrument control, making this a one-man operation producing 1000 tons a month of small normalized tubing.

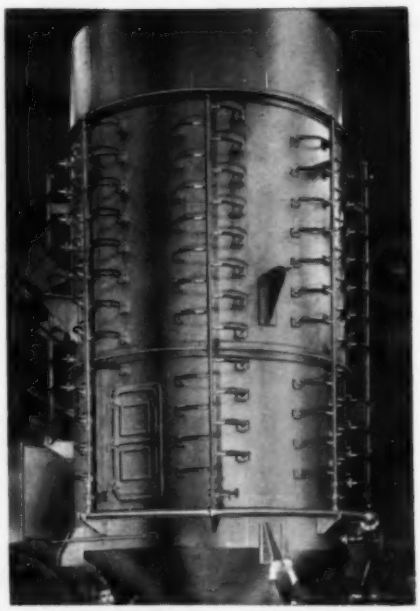
The normalizing line consists of three gas-fired furnaces, each four ft long and having four gas burners. The first two furnaces are used for heating the tubing and have burners of 1,000,000 Btu per hr capacity. They are automatically controlled at 2500 F to heat the pipe body to 1650 F and the upset to 1600 F. The third furnace is used for soaking and has four burners each of 750,000 Btu per hr capacity which are controlled at 1650 F.

Only two sizes of tubing are normalized in this line: 2⅜-in. x 4.70 lb and 2⅞-in. x 6.50 lb. The former moves through the furnaces at about 10 fpm. A speed range of 5 to 20 fpm, controlled by rheostat settings, provides for heat treating the other size.

The normalizing line operation is automatic except for keeping the charging table supplied with tubing by overhead crane and similarly removing the tubing that accumulates on the cooling table. On the charging table, the tubing rolls by gravity to a stop where automatic air-operated selective kick-in arms pick up a length of tubing and roll it onto the furnace inlet table. The kick-in switch is operated by a paddle over which the preceding tube has passed. The tubing is conveyed through the furnaces by the four rolls at the ends of the furnaces, then on to a furnace outlet conveyor. There is another automatic kick-out paddle switch at the end of the outlet conveyor. When depressed by a length of tubing the air-operated kick-out arms discharge the length onto the cooling table.

The new equipment has increased normalizing capacity for all sizes of pipe. The removal of 500 tons of small tubing from two roll-down type tube normalizers has, in effect, increased the capacity of normalizing in these roll downs by 1000 tons of 5½-in. x 23-lb casing.

"BUFFALO" CURED OUR CHIMNEYS OF A STUBBORN SMOKING HABIT!



"Buffalo" Hydraulic Scrubbing Tower

"We were stumped with a problem of coke breeze discharge. Even after cyclone separation, it was heavily loaded — thick and black. To make matters worse, the contaminant was too abrasive and hot for ordinary equipment to handle! Then we talked to a "Buffalo" engineer. He recommended a unit "Buffalo" just recently developed — a Hydraulic Scrubbing Tower. It cleans by wet centrifugal scrubbing. The effects of heat and severe abrasion are overcome. It doesn't clog — needs very little attention. And its collection efficiency is so high that our stack discharge is harmless and almost colorless. When you consider the improved 'neighbor relations' and the simplicity and economy of operation, our "Buffalo" Hydraulic Scrubbing Towers have paid for themselves many times over."

KNOW-HOW PLUS EQUIPMENT FOR YOUR AIR CLEANING PROBLEMS!

"Buffalo" units and "Buffalo" experience cover the entire range of today's specialized air cleaning applications. Why not call on these facilities for the best results on *your* problem — for the famous "Q" Factor* Performance that plants everywhere are enjoying.

**The "Q" Factor — The built-in Quality which provides trouble-free satisfaction and long life.*

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"We prevented Field complaints and motor Burnouts — by protecting our sewing machine drive motors with FUSETRON FUSES."

"By 1949, increased sewing machine speed and stepped-up production tempo were putting an added burden on the drive motors we make for Singer Sewing Machine Co.

"It was necessary to find a more effective way to protect these industrial sewing machine motors — otherwise, we might expect increasing motor burnouts and field complaints.

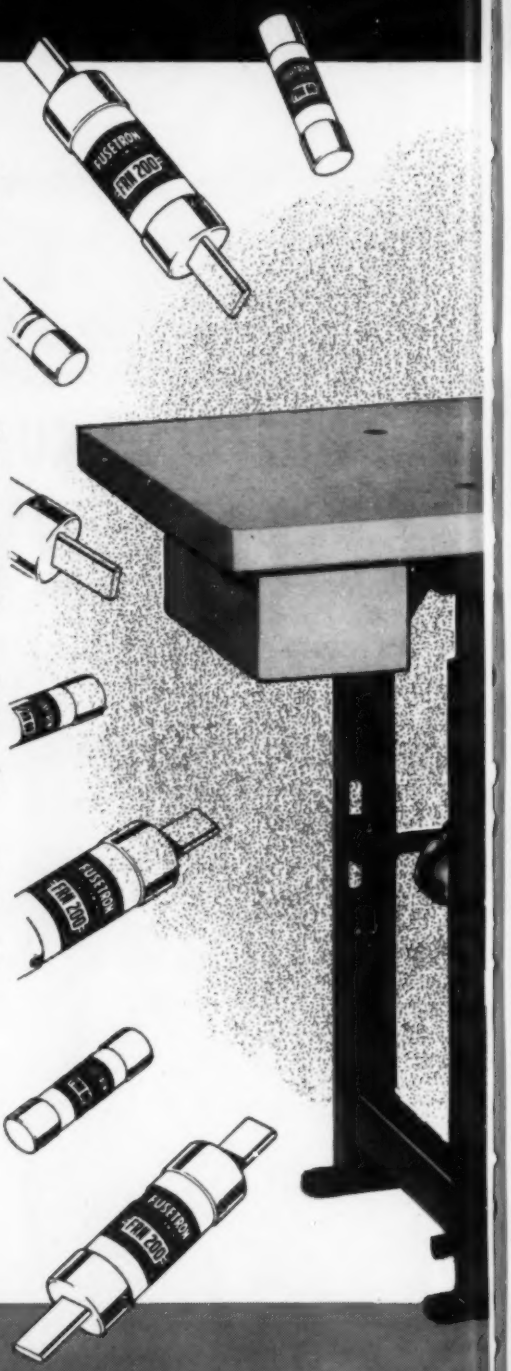
"An extensive test was conducted on the application of Fusetron dual-element fuses of motor-running protection sizes. Our investigation showed that Fusetron fuses, because of their time-lag, would hold the motor starting current. They also would absorb the current surges resulting from starting the sewing machines 40 or more times per minute.

"In addition, Fusetron fuses would safely take the motor off the line if the branch circuit was single phased. We were particularly interested in this finding because we knew this type of power supply fault could give us a lot of trouble.

"On the basis of our tests, we decided to provide individual Fusetron fuse protection as standard equipment.

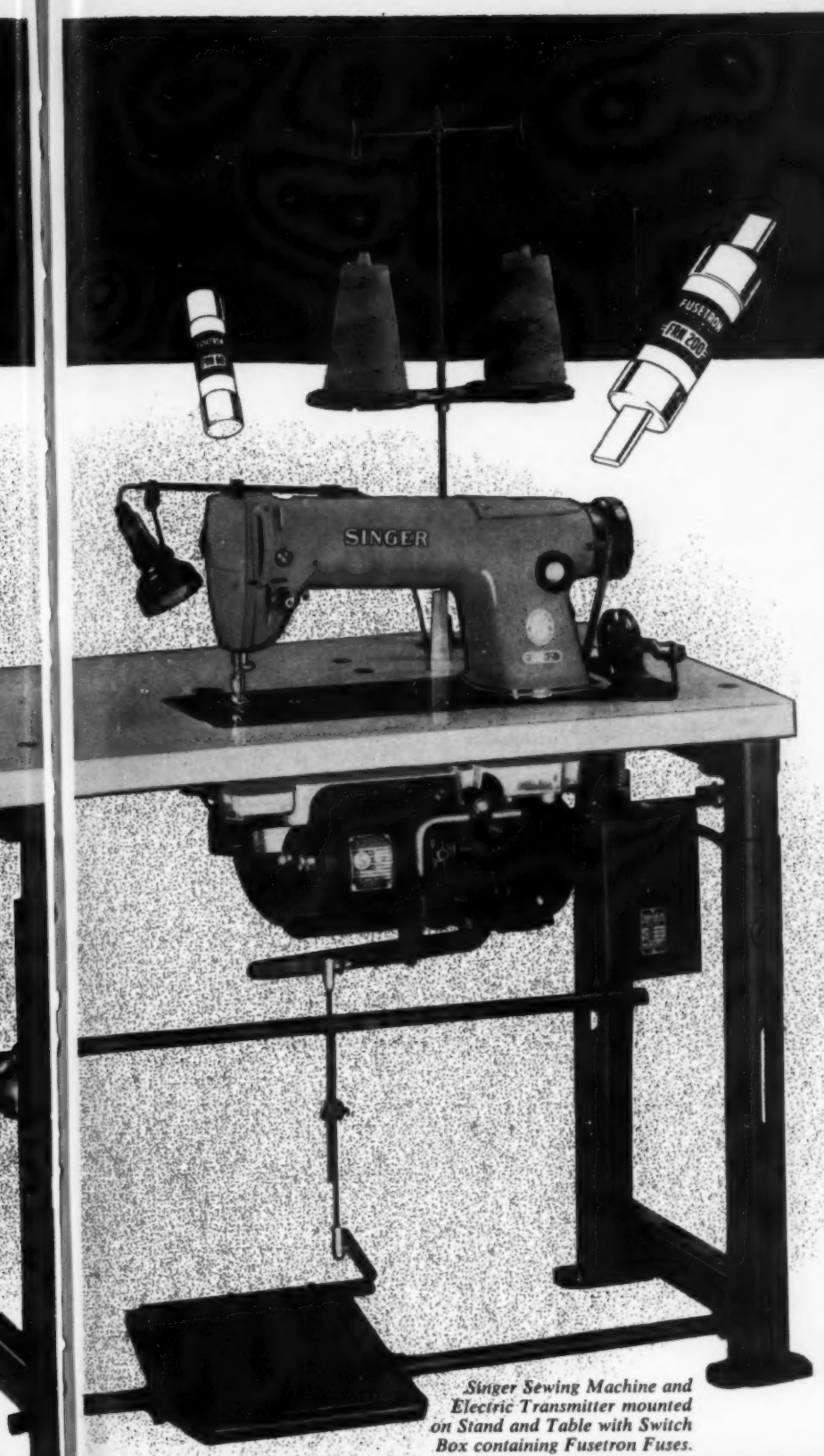
"As we expected, this decision practically eliminated motor burnouts and prevented field complaints."

R. D. Ingalls,
CHIEF ENGINEER
DIEHL Mfg. Co.
Electrical Division of
The Singer Manufacturing Co.
SOMERVILLE, N. J.



***Play Safe!* install Fusetron Fuses and BUSS Hi-Cap Fuses throughout the entire Electrical System.**

You too, can eliminate Protection Troubles with FUSETRON FUSES . . . They provide 10 point protection.



Singer Sewing Machine and Electric Transmitter mounted on Stand and Table with Switch Box containing Fusetron Fuses.

1. High interrupt capacity — protect against heavy short-circuits. Have proven on tests to open safely on circuits set to deliver in excess of 100,000 amperes.
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FOR LOADS ABOVE 600 AND UP TO 5,000 AMPS., . . . *Use BUSS Hi-Cap Fuses*

They have an interrupting capacity sufficient to handle any fault current regardless of system growth.

They can be coordinated with Fusetron fuses on feeder and branch circuits to limit fault outages to circuit of origin.

On new construction, tell your architect to specify this Safer, Better Protection.

356

For detailed information on Fusetron dual-element fuses and BUSS Hi-Cap fuses, write for bulletin FIS and HCS.

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FUSETRON
TRUSTWORTHY NAMES IN ELECTRICAL PROTECTION
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Getting finished material out of the mills and to storage as soon as possible helps eliminate congestion problems. This 1200° F., 32,000 lb. load is being moved to storage to cool. At Crucible Steel's Midland Works, the six Clark-Ross Carriers are moving material at an average of 450 tons each, per 8 hour shift.

Mill Congestion Problem?

LOOK WHAT CRUCIBLE DID!

How to handle and store in-process and finished material is a problem to most steel mills, no matter how modern. Faced with inflexible handling methods, congestion and lack of storage space, Crucible Steel's Midland Works took bold action.

In came six Clark-Ross* Carriers—open ground between buildings, next to roadways, and even outside doorways, became storage area for in-process materials.

Minutes after a call for material, a giant Carrier straddles a load, picks it up in seconds, delivers it *where* it's needed. Even hot steel is moved while at temperatures as high as 1400° F. These hot bars are cooled in storage rather than within the mill.

No need for tracks, cranes or special crews—the Clark-Ross Carrier's inherent mobility, speed and flexibility have made transportation between mill and outside storage practical. Full details. Write for Case Study 24-D1-33.

Every piece of open ground between buildings, next to roadways, and even outside doorways, has become storage area for in-process materials at Crucible Steel's Midland Works.

*Clark-Ross is a Trademark of Clark Equipment Company

CLARK® EQUIPMENT

Ross Carrier Division
CLARK EQUIPMENT COMPANY
Battle Creek 135, Michigan

A BETTER BUY WITH LOCAL SUPPLY—*Genuine Clark Parts*

COAGULANT AID SAVES ALUM

Figure 1 — Coagulant aid in powdered form is being added to the mixing tank. Slurry in turn will be introduced into the water clarification system to help speed up the flocculating action of the coagulant, alum.

▲ A new type of coagulant aid, a mixture of polyelectrolyte and bentonite clay, is being used in an automatic water clarification and demineralization system at Jones & Laughlin Steel Corp's tin plate department, Aliquippa, Pa. The new aid, made by Hagan Corp., Pittsburgh, saves J&L an estimated 30 per cent in the amount of alum coagulant used, and simplifies control of the clarifiers and control of the sludge blanket in the clarifiers.

Other advantages are cited by John Sargent, J&L chemical engineer. The coagulant aid causes the sludge blanket to be more stable and less sensitive to upflow rates. It helps to produce an improved tough and rapid settling floc and reduces the dosages of other chemicals to a minimum.

The reduction in alum dosage in turn has reduced the amount of alkali addition necessary for pH adjustment. There also has been a reduction in regeneration chemical cost and decreased number of regeneration cycles in the deionizing operation which follows clarification.

Time consuming jar testing, necessary previously to guide chemical dosages, has been entirely eliminated. The company also saves in chemical handling and storage space.

At the J&L plant, located on the Ohio River below Pittsburgh, water in great quantities is used in rinses, quenches and in cleaning and plating solutions in the electrolytic tinning lines. All of the water must be clear and free of impurities, to produce fine quality tin plate that is free of stains, streaks and surface irregularities.

The water conditioning system, installed in 1951 to serve the tin mill needs, processes 4,000,000 gal of clarified water and 1,000,000 gal of demineralized water per day. Water drawn from the muddy Ohio river has a maximum hardness of 255 ppm, a dissolved solids content as high as 600 ppm and a turbidity varying from 20 to 2000 rpm.

Suspended solids are removed by continuous coagulation and settling in two Cochrane clarifiers.

The flocculating chemicals are introduced ahead of the reactors, in varying quantities, depending upon flow of water to the reactors. In the clarification process, river water is pumped at the rate of 3000 gpm through three Kellan strainers to a mixing stand where the flow is divided between the two reactors. Rates of flow to the reactors are measured, recorded and integrated and the flocculating chemicals — alum, caustic soda and the coagulant aid—are fed into the system. Rate of feed of the chemicals is controlled by an electrical contact counter.

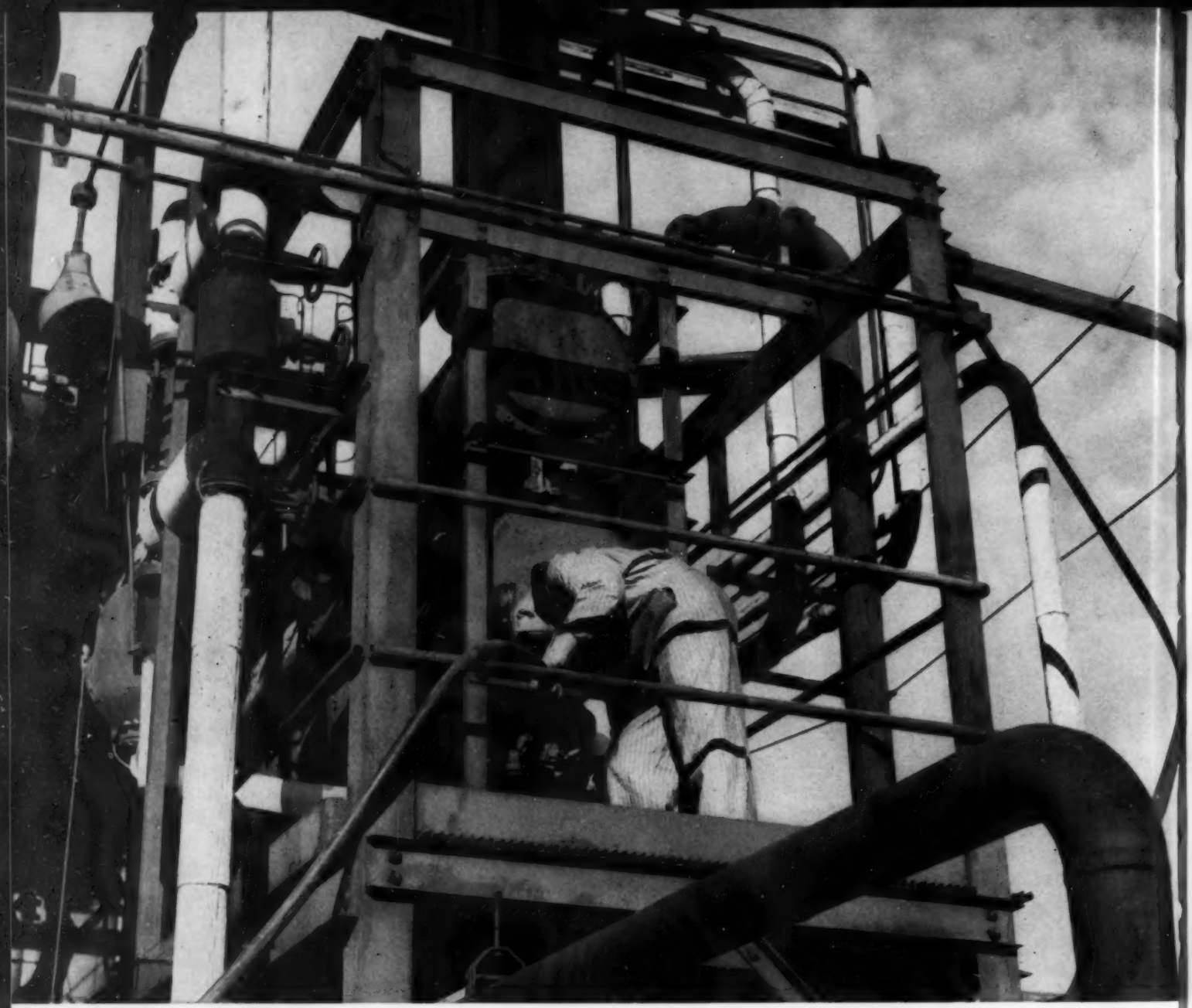
The free-flowing Hagan coagulant aid is added in powdered form in a mixing tank and fed just ahead of the clarifiers. The amount of aid is carefully proportioned into the water. Dosage ranges from 5 to 15 ppm.

The slurry is mixed quickly and thoroughly with the raw water to be treated, helping to speed up the flocculating action of the alum. The aid causes the floc which enmeshes the finely divided sediment, to form more quickly, to be tougher, and to settle more rapidly.

A large portion of the clarified water, approximately 2300 gpm, is pumped directly from the clarifier outlet to point of usage. This water is not filtered; it has a turbidity less than 10 ppm, and is used in the preplating operations and in sensitive heat exchanger applications. Another stream of water from the clarifiers, about 750 gpm, is pumped to pressure filters and then to the demineralizing plant. After demineralization this water, paralleling steam condensate in purity, is used in the tinplating and post-plating sprays where water purity is of vital importance.

Development of the system at J&L was the result of close cooperation between Hall Laboratories, a subsidiary of Hagan Corp., Cochrane Corp. of Philadelphia, and J&L engineers.

Figure 2 — The two open basins are Cochrane clarifiers operating in parallel. The plant processes muddy raw water from the Ohio River, producing 4,000,000 gal of clarified and 1,000,000 gal of demineralized water every day.



There's too much at stake —clean it right

Chemical cleaning involves costly equipment and often work stoppages. It's a job for experts. Let Dowell protect that equipment and keep production losses to a minimum when you have scale or sludge problems.

In over 15 years our trained engineers have serviced virtually every kind of equipment in plants, mills and refineries throughout industry. In fact, Dowell has cleaned over 10,000 boilers alone!

This experience means lower costs to you—in more thorough work, restored efficiency and less production loss.

Furthermore, Dowell engineers know you value the safety of your men and equipment. Dowell uses only the latest safety equipment and techniques to eliminate hazards and accidents. Our engineers work closely with your safety personnel to establish the safest possible working procedures.

Call the nearest of more than 165 Dowell offices. An experienced engineer will be glad to talk over and help you with your cleaning problems any time — at no obligation. Or write Dowell Incorporated, Tulsa 1, Oklahoma, Dept. C-29.

chemical cleaning service for industry

DOWELL

A SERVICE SUBSIDIARY OF THE DOW CHEMICAL COMPANY

Date-line Diary...

February 2

▲ Detroit Steel Corp. announced it will soon restrict orders it accepts for cold rolled sheets to widths over 12 inches.

▲ Auto and truck production last month, as reported by Ford, Chrysler and General Motors, dropped 8 per cent from December and was 6.7 per cent below the January 1955 total.

February 3

▲ General Motors reported a profit of $1,189,000,000 during 1955, making them the only corporation in history ever to push one year's profits over the billion dollar figure. Their 1955 earnings equaled $4.30 per share on common stock.

▲ A record of $10,400,000,000 was paid in cash dividends by corporations during 1955 which was over $1,000,000,000 more than paid in 1954.

February 6

▲ The AISI reports that the operating rate of the steel industry for the week of February 6 is scheduled at 97.6 per cent of capacity. This is equivalent to 2,403,000 tons compared with 2,444,000 tons one week ago and 2,095,000 tons one year ago. Index of production for the week is 149.6.

▲ Auto companies are cutting their steel buying and some producers have been notified to cut shipments to auto plants during April by 10 to 20 per cent.

February 7

▲ Kaiser Steel Corp. started production on a $2,000,000 order of equipment for a new pipe mill in Welland, Canada. This mill will manufacture large diameter steel pipe, from 20 to 36 in. and is scheduled for completion by January 1, 1957.

▲ According to the Commerce Dept. personal income reached a record rate of $315,000,000,000 annually during December. This was $3,000,000,000 above the November pace.

February 8

▲ Employment during January set a new high for the month with jobholders totaling 62,900,000, a decline of 1,300,000 from December but 2,700,000 more than January of the previous year.

February 9

▲ The Aluminum Association reported primary production of aluminum in December totaled 281,496,030 lb in comparison with 267,377,623 in November and 254,069,331 in December 1954.

▲ Price boosts on soft coal ranging from 15 to 50 cents per ton will go into effect on April 1. The boosts are a result of increasing production costs including the 80-cents per day wage hike which will go into effect that day.

▲ According to the Commerce and Labor Depts., building expenditures during January fell 10 per cent below December with $2,849,000,000.

February 10

▲ American Potash and Chemical Corp. announced substantial price reductions in quantity lots of elemental boron ranging up to a 35 per cent price decrease in quantities of 100 lb or more.

▲ Chrysler Corp. earnings statement revealed that last year's net rose to $11.49 a share compared to $2.13 for 1954; the sales increase over the previous year was 67 per cent to a total of $3,400,000,000.

February 12

▲ The Bureau of Mines reports that the December consumption of ferrous materials, scrap and pig iron, increased 1 per cent over November, and total melt (12,594,000 gross tons) was 51.6 per cent scrap and 48.4 per cent pig iron. In December, scrap and pig iron consumption was respectively 6,493,000 and 6,101,000 gross tons.

February 13

▲ Contract awards in January for future construction totaled $1,858,228,000 in the 37 eastern states for a new record. This figure, according to the F. W. Dodge Corp. was an increase of 25 per cent over January 1954.

▲ Iron and steel casting shipments, reported by the U. S. Department of Commerce, for November 1955 amounted to 1,557,000,000 short tons. This is approximately equal to October 1955 total shipments, but 35 per cent above November 1954.

February 14

▲ The Association of American Railroads, in defending the 7 per cent freight rate increase at the hearings by the ICC, estimated that rail labor costs had increased $413,000,000 yearly by last fall's wage boosts, and an additional $4,000,000 by pay hikes since the start of 1956.

February 15

▲ The AISI reports that the operating rate of the steel industry for the week of February 13 is scheduled at 97.8 per cent of capacity. This is equivalent to 2,408,000 tons compared with 2,439,000 tons one week ago and 2,150,000 tons one year ago. Index of production for the week is 149.9.

▲ A second decline in three weeks took place in scrap prices with reductions of $1 to $3 a ton in the Pittsburgh area and $2 a ton at Chicago.

▲ Alcoa announced a third foil mill expansion program within a year.

▲ Crucible Steel Co. of America declared a 75 cents per share common stock first quarter dividend to stockholders on record at March 1, 1956, which is an increase of 25 cents per share. Announced also was a plant expansion and improvement program of $20,000,000, with $11,000,000 being spent at the Midland Works to increase the capacity to roll finished stainless steel sheet and strip.

February 16

▲ Birdsboro Steel Foundry and Machine Co. received an order for a hot and cold reversing mill for processing atomic fuel elements at a cost of approximately $125,000 from Combustion Engineering Inc., New York.

▲ Allegheny Ludlum Steel Corp. declared a first quarter 1956 dividend of 40 cents per share which considering the two-for-one stock split in January, is comparable to a 37½ cent dividend for the previous

quarter. A new major $30,000,000 expansion program was authorized for production of stainless, electrical, and high alloy specialty steels.

February 17

▲ The Colorado Fuel and Iron Corp. announced all outstanding fifteen-year, 4¾ per cent convertible debentures due December 1, 1966 are now redeemable, with redemption date March 30, 1956, at a price equal to 103 per cent of principal face amount, plus accrued interest to redemption date. These debentures are convertible into common stock at $20.75 per share, with rights to convert expiring March 20, 1956.

▲ Lukens Steel Co. announces an increase of about 2 per cent in price in "extras" on Lukens nickel, monel, inconel and stainless clad steel plate.

▲ Deliveries of new domestic freight cars in January totaled 4199 compared with 3796 in December and 2008 in January one year ago, according to the ARCI. Orders in January totaled 1818 compared with December's 42,278. Backlog of cars on order on February 1 stood at 144,946 cars.

February 18

▲ According to The Aluminum Association, primary aluminum production in the U. S. for January totaled 280,787,668 lb in comparison with 281,496,030 lb in December and 256,406,748 lb in January one year ago.

February 20

▲ General Electric Co. announced 1955 sales at $3,095,352,063, an increase of 5 per cent over 1954 sales. The earnings for 1955 were $200,923,835, or $2.32 per share of common stock, compared with 1954 earnings of $2.30 a share.

▲ The AISI reports that the operating rate of the steel industry for the week of February 20 is scheduled at 98.5 per cent of capacity. This is equivalent to 2,425,000 tons compared with 2,433,000 tons one week ago and 2,191,000 tons one year ago. Index of production for the week is 151.0.

▲ The price increase of 85¢ scheduled for 1956 shipments of Mesabi grades of iron ore have been trimmed by a major ore producer to 75¢ for standard grades with 51.50 per cent iron content.

▲ U. S. Department of Commerce reports that gray iron castings shipments in December amounted to 1,260,000 short tons, 4 per cent below November shipments and 17 per cent above shipments in December 1954. Malleable iron castings shipments for December 1955 amounted to 100,000 tons, approximately equal to November shipments, and about 14 per cent above December 1954. Steel castings shipments for December totaled 159,000 tons, 4 per cent above November shipments and 70 per cent above December 1954 shipments.

February 23

▲ The highest sales in its history were announced by Allis-Chalmers Manufacturing Co. for 1955, totaling $535,069,085, exceeding 1954 sales by $42,000,000. Net earnings amounted to $24,805,326 or $6.05 per share of common stock.

▲ Woodward Iron Co. reported that it plans to spend $8,700,000 on its Birmingham facilities in 1956.

February 24

▲ The Pittsburgh Coke and Chemical Co. reported 1955 sales of $56,600,000, 50 per cent more than in 1954. Net earnings in 1955 of $3,093,000 or $2.34 per share compared with 1954 earnings of $1,084,000, or $0.71 per share.

▲ General Refractories Co. announced sales for 1955 amounted to $56,536,641, compared with $37,436,338 in 1954. Net earnings in 1955 were $6,011,516 or $4.87 per share compared with $2.27 per share for 1954.

February 27

▲ Bethlehem Steel Co.'s expansion program, over the next two years, will cost about $300,000,000, adding more than 3,000,000 tons to its annual steel ingot capacity. The company plans to spend an additional $100,000,000 on its share of the Erie Mining Co. ore project, 45 per cent of which is owned by Bethlehem.

▲ Machine tool makers' January's incoming business dropped to $118,000,000 compared with the record peacetime figure of $157,000,000 in December; and the $60,000,000 for January 1955.

▲ Industrial Heating Equipment Association, Inc. reports that the orders received by member companies for industrial furnaces for January 1956 showed a 106 per cent increase over January a year ago, with orders of $10,244,066 compared with $4,973,088 for January 1955.

▲ The AISI reports that the operating rate of the steel industry for the week of February 27 is scheduled at 98.4 per cent of capacity. This is equivalent to 2,422,000 tons compared with 2,433,000 tons one week ago and 2,218,000 tons one year ago. Index of production for the week is 150.8.

February 28

▲ Inland Steel Co.'s annual report disclosed that the company will spend a record $75,000,000 during 1956 for expansion and improvement. This is part of a three-year $260,000,000 program which has been announced, and will bring the ingot capacity to at least 6,000,000 tons annually by late 1958, an increase of 800,000 tons.

▲ Argentina was granted a $60,000,000 credit by the Export-Import Bank to help finance construction of an integrated steel mill. This will cover 60 per cent of the purchases in the United States for the mill, estimated to cost a total of $258,000,000, to be built by the Sociedad Mixta Siderurgia Argentina, at Nicolas, Argentina, on the Parana River.

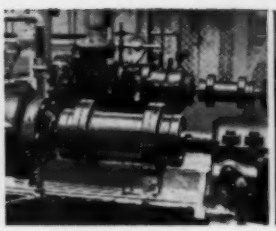
▲ Mesta Machine Co. announced a net income of $3,653,945 or $3.65 per share for 1955 as compared with $5.38 per share in 1954. However, unfilled orders at the end of 1955 amounted to $91,400,000 compared with $29,600,000 at the end of 1954, or the largest backlog in the company's history.

▲ Reynolds Metals Co. netted the highest net profit in its history in 1955, with $34,306,521, equal to $3.41 per share compared with $20,280,908, or $2.02 per share in 1954. Sales in 1955 totaled $384,887,790.

February 29

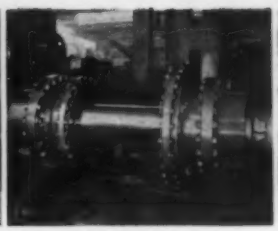
▲ The present 52 per cent corporate taxes will prevail for another year, and the House Ways and Means Committee voted to rescind the reduction of 5 per cent which was to have been effective April 1 under the present law. Continuation to April 1, 1957 of the excise levies on liquor, cigarets, gasoline and motor vehicles was also approved.

Paper Industry

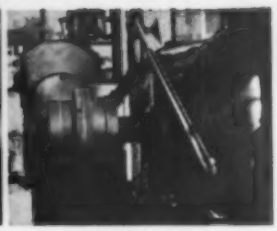


Oil and Gas Industry

Marine Industry

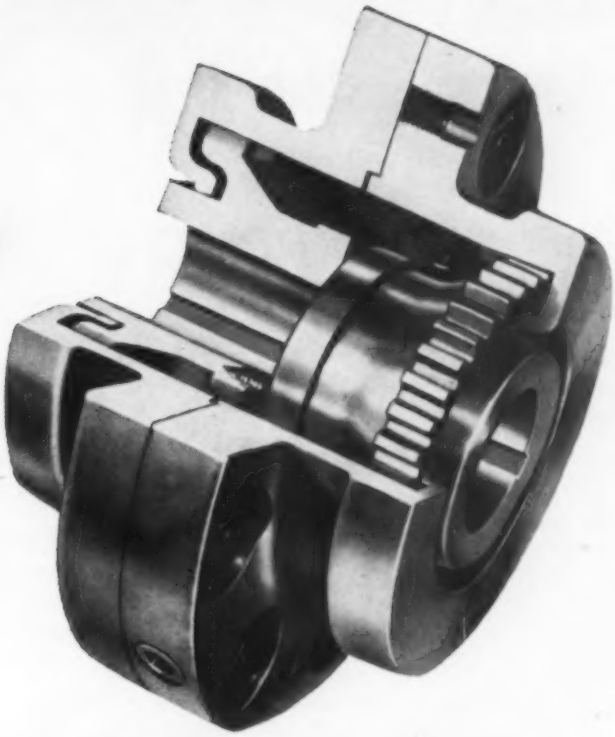


Steel Industry

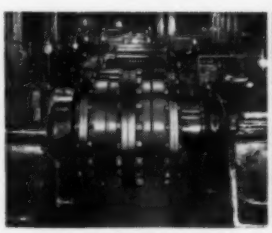


Oil and Gas Industry

Why have Fast's Couplings always been the leader in the rugged steel industry?

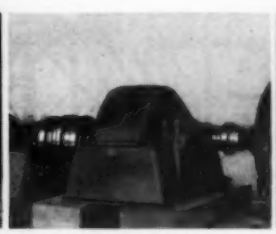


Why are they used so widely to couple machinery in Power Generation, Pulp and Paper, Oil and Gas, Marine Propulsion and Auxiliaries, Steel and industry in general?

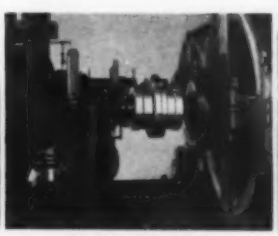


Steel Industry

Power Industry



Lumber Industry



Chemical Industry

Paper Industry

Fast's Couplings are standard equipment with more machinery manufacturers than any shaft coupling on the American market. Many Fast's Couplings in use over 30 years still show no signs of wear when disassembled! That's the answer: they're reliable, they're *mechanically* flexible, they don't wear. They have no parts subject to repeated bending, tension or compression. There is no metal-to-metal contact, because of *positive lubrication.* Regardless of your field—no matter whether your connected machine is driven by steam turbine or electric motor, low-speed diesel or high-speed gas turbine . . . Koppers has the perfect, low-cost solution to your shaft coupling problem.

For free catalog write to: KOPPERS COMPANY, INC., *Fast's Coupling Dept.,* 3003 Scott St., Baltimore 3, Md.

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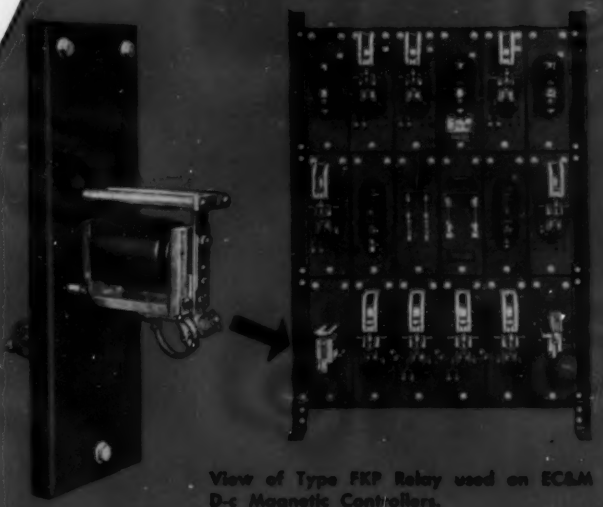
THE ORIGINAL

FAST'S Couplings

When Stopping D-C Motors . . . EC&M's Rectifier Plugging Control System gives FULL PROTECTION



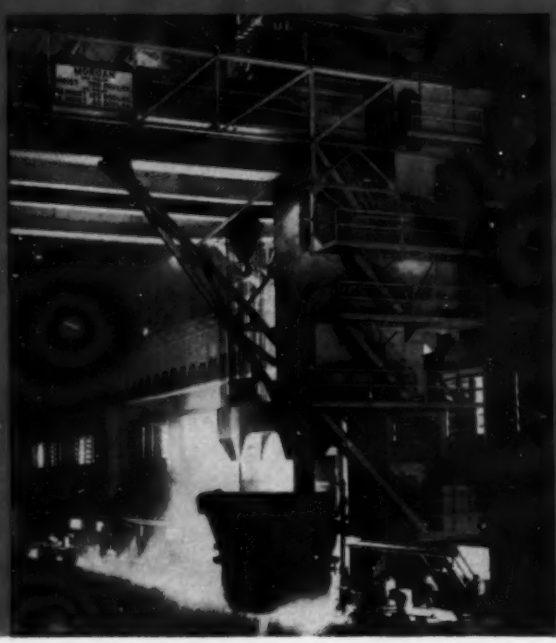
View of Type FKP Relay used on EC&M D-c Magnetic Controllers.

This is the simplest of plugging control systems for d-c mill and crane drives. Only a small rectifier and single-coil, mill-duty relay are required. They are connected across the motor armature for operation by counter-emf. The relay allows the Plugging Contactor to close immediately when starting from rest. When reverse-power plugging is applied to stop the motor, the rectifier permits the relay to pick up and hold open the plugging contactor. As the motor reaches stand-still, the relay drops out to close the plugging contactor and allow acceleration in the opposite direction.

The advantages of EC&M Magnetic Control are many. Ask an EC&M Engineer to explain the improved operation of d-c motors by Rectifier-Plugging.

Reasons why Motor Drives are better protected . . .

1. Positive response — relay operates directly from counter-emf of motor.
2. Reliable operation — unaffected by line voltage variation. Unaltered if taps on accelerating or plugging resistors are changed.
3. Full protection — relay picks up at any speed above 10% of F.L. motor speed. Drop-out occurs as motor reaches standstill.
4. Simplicity — a single-coil relay, a small rectifier, no electrical interlocks.
5. Reduces maintenance — relay does not require adjustment-maintenance.



Two-step Plugging Controllers are available for use on heavy inertia loads, such as ore bridge trolleys and ladle crane bridge motions.

THE ELECTRIC CONTROLLER & MFG. CO.

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roll higher tonnage records with TORRINGTON work roll BEARINGS

TORRINGTON WORK ROLL BEARINGS are helping to set new tonnage records wherever they are used. And why not! They're designed and built to do just that. Every detail of construction from the electric furnace steel used in their construction to the precision-ground races and rollers work to one objective: to provide the steel industry with the finest bearings possible for long, heavy-duty service. Keep your production rolling to new records. Both two-row and four-row types of TORRINGTON WORK ROLL BEARINGS are standard in a wide variety of sizes. Next time make it TORRINGTON. There's none better.

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Spherical Roller • Tapered Roller • Cylindrical Roller
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THE TORRINGTON COMPANY

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THE TORRINGTON COMPANY 90th ANNIVERSARY 1866–1956

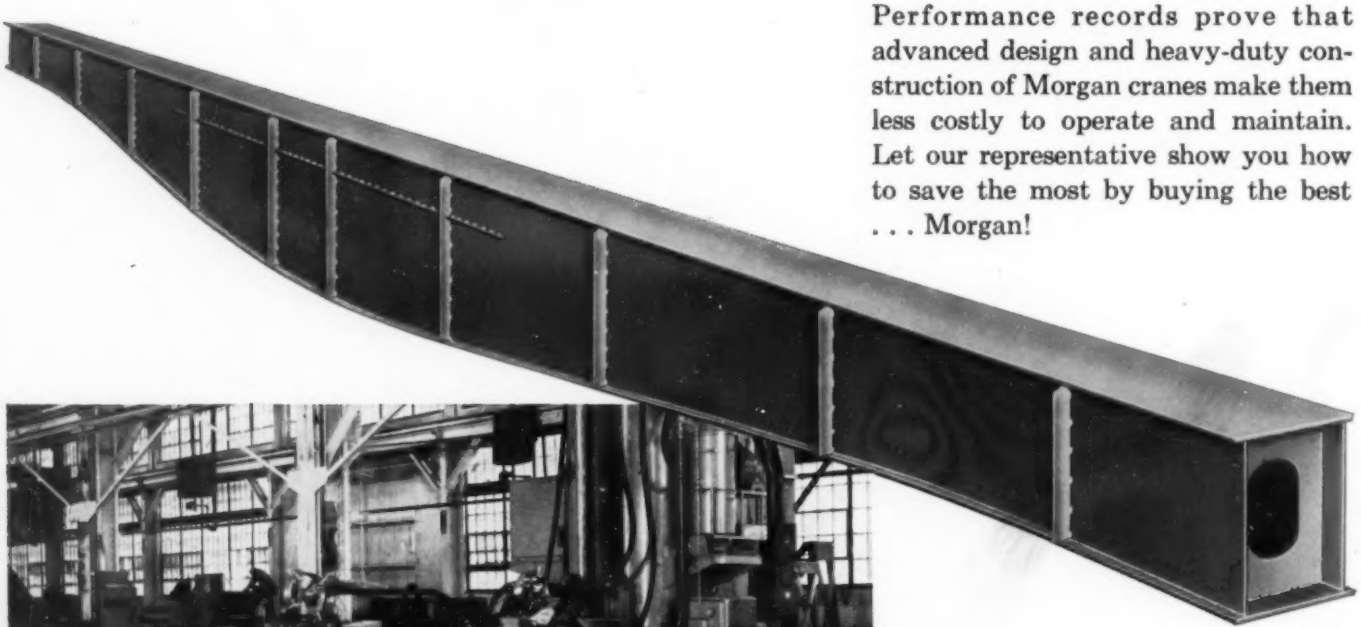
How Morgan cranes get a stiffer backbone ...automatically

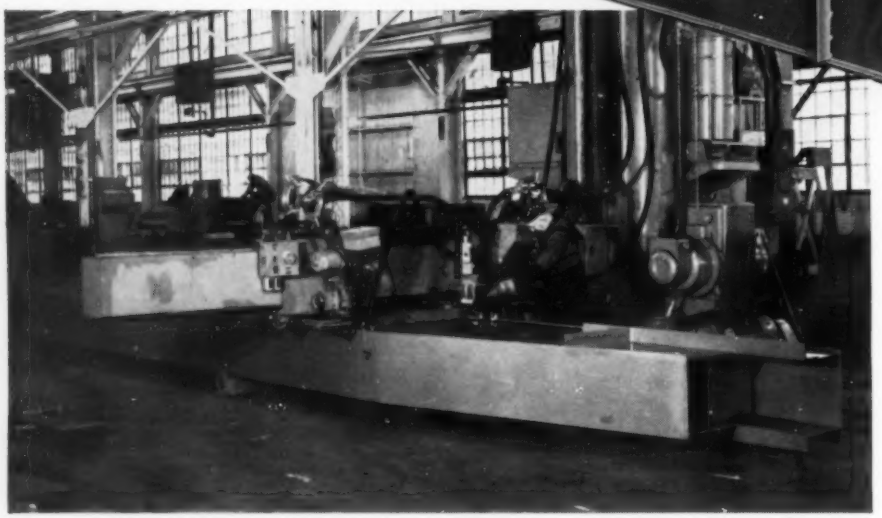
● MORGAN CRANES are stronger, more rigid . . . because girder joints and seams are welded automatically on the world's largest continuous welder. Casting imperfections and hand welding variables are eliminated with Morgan automatic welding. All joints are uniform and sound.

Crane drums, too, are welded automatically, making them stronger and lighter. Casting shrinkage voids are eliminated.

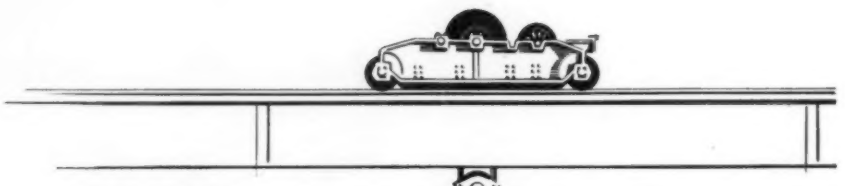
Morgan welders are qualified in accordance with A.S.M.E. and A.W.S. codes.

Performance records prove that advanced design and heavy-duty construction of Morgan cranes make them less costly to operate and maintain. Let our representative show you how to save the most by buying the best . . . Morgan!



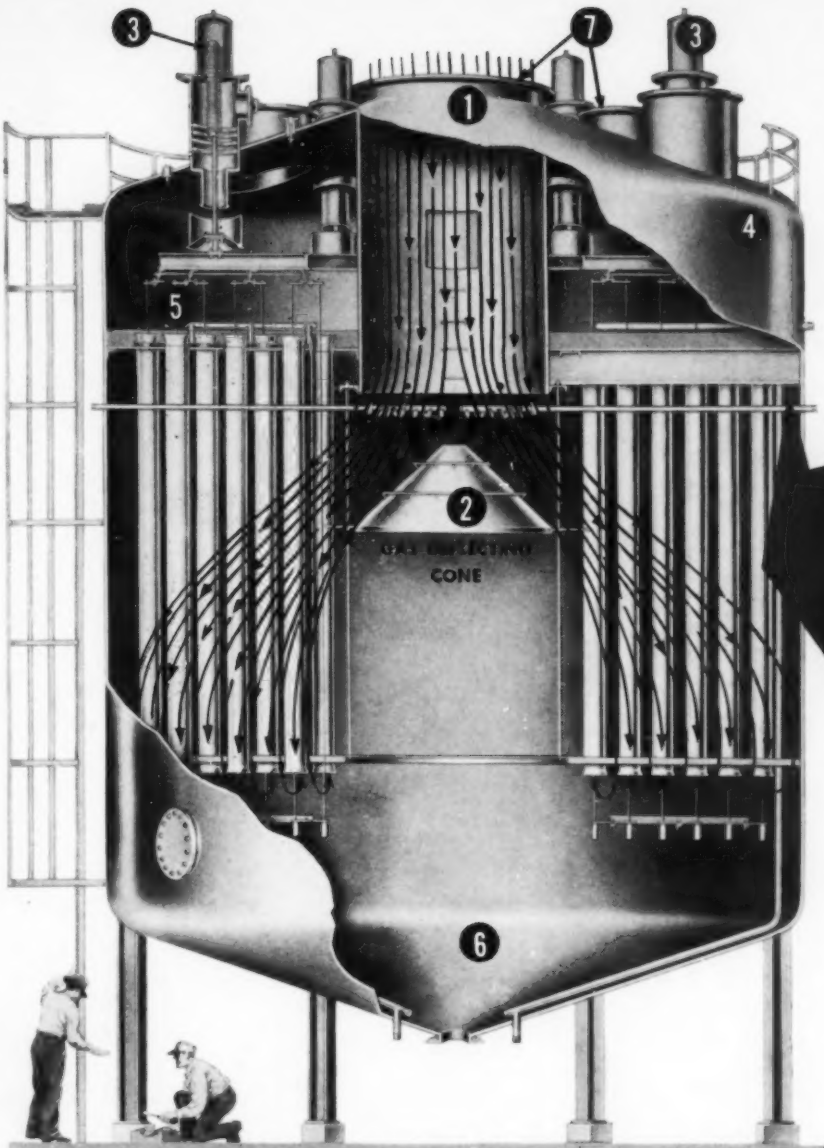


Perfect welding penetration is obtained with Morgan's 120" per minute automatic welder. Two welding heads float vertically and horizontally along the track.



The Morgan Engineering Company, founded in 1868, manufactures overhead electric traveling cranes, gantry cranes, charging machines, plate mills, blooming mills, structural mills, shears, saws, and auxiliary equipment.

THE
MORGAN
ENGINEERING CO. *Alliance, Ohio*



NEW BLAST FURNACE COTTRELL PRECIPITATOR

Better Gas Distribution Gives Higher Operating Efficiencies!

Western Precipitation Corporation, who until recently limited its sales of iron BLAST FURNACE COTTRELL PRECIPITATORS to the Western United States, Canada, South America and Australia, now offers an improved design for sale throughout the entire United States and all foreign countries. This new development provides better gas distribution . . . improved flue connections . . . simpler insulator compartments . . . greater freedom from clogging . . . and more efficient manifolding of multiple units.

Key to the new design is the top center inlet and a deflecting cone that assures uniform gas distribution to each separate collecting electrode pipe in the unit.

Result . . . collecting electrodes are more evenly "loaded" . . . higher overall efficiency is achieved . . . and other important advantages are obtained as outlined at left.

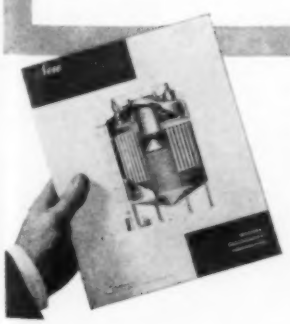
A few of the companies installing this new COTTRELL Precipitator include . . .

Australian Iron and Steel Ltd.
Crucible Steel Company
Detroit Steel Corporation
Dominion Foundries and Steel Co., Ltd.
Jones and Laughlin
U. S. Steel Company

Our experienced engineers will be glad to provide you technical data and performance records on this new COTTRELL development without obligation . . . or write for full details.

Advantages of the new Blast Furnace COTTRELL

1. **Gas enters downwardly** through top center inlet.
2. **Gas deflecting cone** provides uniform gas distribution to *all* the collecting pipes in the unit.
3. **Insulator compartments** are above and outside the gas stream, assuring better protection, less maintenance.
4. **Cylindrical design** permits better spacing of collecting electrodes for improved gas flow.
5. **Collected material** is continually washed from inside surface of collecting pipes by film of water from "ponds" in top header. Adjustable weir rings for each pipe assure proper water film, and once set, rarely require readjustment.
6. **Cone bottom** simplifies recovery and disposal of collected material washed from pipes.
7. **Grouping of gas inlet and discharge connections** at the top saves ground area and costly goggle valves, and permits multiple units to be easily manifolded.



These are only a few of many advantages. Get the complete story from our nearest office—or write direct!

Send for Bulletin C-119 which describes this new Blast Furnace Cottrell!

WESTERN Precipitation CORPORATION

DESIGNERS AND MANUFACTURERS OF EQUIPMENT FOR COLLECTION OF SUSPENDED MATERIALS FROM GASES & LIQUIDS

Main Offices: **1067 WEST NINTH STREET, LOS ANGELES 13, CALIFORNIA**
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PRECIPITATION CO. OF CANADA, LTD., DOMINION SQ. BLDG., MONTREAL

TSP table bevel gears for 44" blooming mill.

TSP

Hardened Products

TSP track wheels on ore transfer car.

TSP trunnion rollers on car dumper.

The "Tool Steel Process" hardened products illustrated are some of those that have been in use in diversified applications at the Geneva Works, Columbia-Geneva Steel, Division United States Steel Corporation, Geneva, Utah, since this mill was built. TSP products deliver extra long life under the severest operating conditions.

HERE'S WHY: TSP products are hardened by our special process. The file hard surface to full depth of permissible wear gives maximum life. The core, refined for toughness and ductility, gives maximum strength. You receive an absolutely positive written guarantee that TSP products will give a longer life in the same service than any other product.

Our long experience in the Steel Industry, our special production facilities, metallurgy and engineering . . . all combine to make TSP products YOUR best investment.

THE TOOL STEEL GEAR AND PINION CO.
CINCINNATI 16, OHIO, U.S.A.

Wagner®
CRANE-BRIDGE BRAKES
...the choice of leaders in industry

131 CRANES at Aliquippa... all equipped with Wagner Hydraulic Crane Brakes

There are 131 overhead traveling cranes in operation at Jones & Laughlin's Aliquippa Works and *all* of them are equipped with Wagner Hydraulic Crane Bridge Brakes.

This is because J&L is interested in safety, economy, and ease of crane brake operation. J&L has found that Wagner crane bridge brakes rank high in these three considerations.

The 75-ton Bessemer crane shown here is equipped with Wagner *Powered* Hydraulic Crane Bridge Brakes. These brakes are:

SAFE because cranes can be controlled without bridge motor plugging which causes damage to both motor and gears. Parking brakes can be set automatically in case of power failure.

ECONOMICAL because operators are less likely to drag *powered* brakes. There's less wear on wheels and lining... life of equipment is prolonged. Several brakes can be operated from one pedal so it's easy to step up production.

EASY-TO-OPERATE... tip-toe braking... finger-tip parking... one-minute bleeding.

Wagner power units can be added to your present Wagner Hydraulic System. Only six weeks are required to fill the average order. Bulletin IU-36 gives full details—write for your copy today.

Type H or HM2 Brake Unit

Hydraulic power unit driven by totally-enclosed motor

Wagner Electric Corporation
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AUTOMOTIVE BRAKE SYSTEMS—AIR AND HYDRAULIC

155-3

Number One of a Series of Advertisements

The massive Pyramids at Giza were painstakingly built as a lasting memorial. Their existence remains a tribute to precision craftsmanship and installation engineering. Although methods have been changed to coincide with the machine age the same attention to engineering detail has enabled the Eichleay Corporation to create impressive installations in all fields of industry.

The installation of mechanical equipment requires careful planning and specialized engineering, in all of which the Eichleay Corporation has shown leadership. Eichleay versatility and outstanding ability have been demonstrated by the speedy and economical solution of difficult installation projects in ferrous and non-ferrous plants, paper mills, power companies and many other industries throughout the nation.

To study your particular project and plan a construction schedule for you, which places your new facility in early operation or minimizes interruptions when existing facilities are involved, is one of the many Eichleay services offered to industry.

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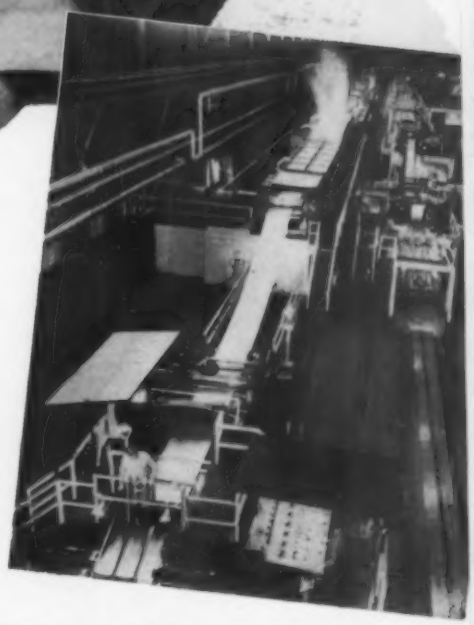

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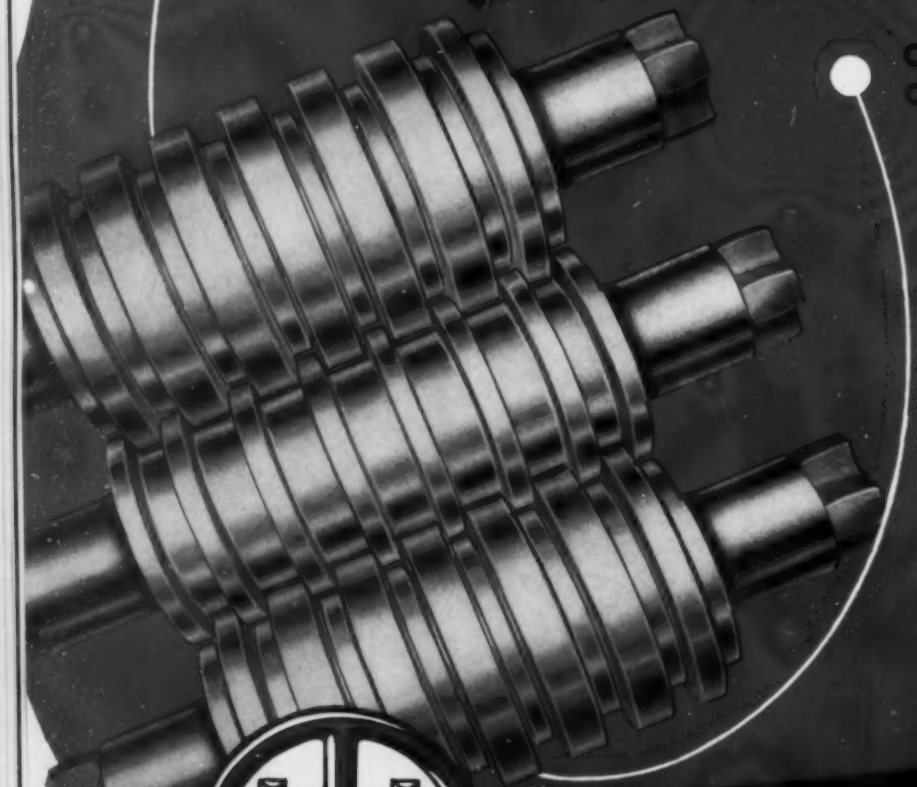
shaping metal for all industry



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THE OHIO STEEL FOUNDRY CO.

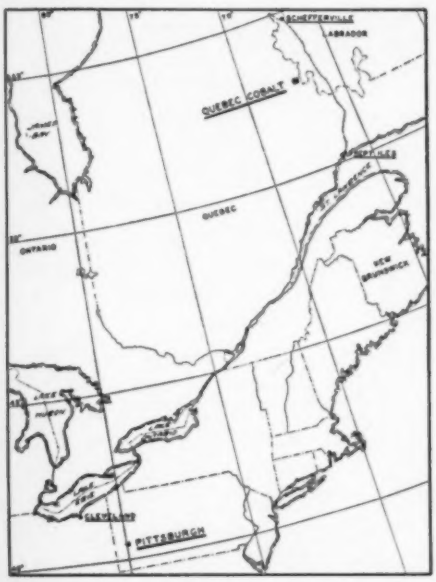
LIMA, OHIO

Plants at Lima and Springfield, Ohio

Industry News...

J&L TAKES OPTION ON NON-MAGNETIC LOW GRADE IRON ORE DEPOSIT IN QUEBEC

▲ Jones and Laughlin Steel Corp. took an option on a large deposit of iron ore in Quebec, Canada, which it will explore over the next two years. The agreement was signed with the Quebec Cobalt & Exploration Ltd. of Montreal.



J&L iron ore reserve is 100 miles south of the producing property of the Iron Ore Co. of Canada.

The deposit, a reserve of non-magnetic low grade ore, is situated 200 miles north of the iron ore port of Seven Islands and 40 miles from the Quebec, North Shore & Labrador Railway.

The reserve is estimated by Quebec Cobalt at approximately 250 million tons of concentrates. If the deposit is proved by the impending J&L exploration, the ore will have to be beneficiated to produce high grade ore containing 60 to 65 per cent iron, probably in the form of pellets. Such beneficiation will require a large investment in plant and equipment to process the ore.

Quebec Cobalt estimates the quality of the crude at 32 per cent iron. The crude is believed to be chiefly a non-magnetic type of ore.

J&L has agreed to spend $250,000 on exploration of the property over a two-year period. The corporation will drill the property this summer, starting work as soon as weather permits. Only surface of the property has been explored to date. There has been no drilling.

If J&L elects to operate the property, the corporation will pay a royalty to Quebec Cobalt.

The entrance of a major American steel producer into this area extends the potential iron ore area of Quebec and indicates the possibility of the development of a major new iron ore producing region in Quebec at the southern end of the Labrador Trough.

AWARDS MAJOR CONTRACT FOR SPARROWS POINT

▲ Bethlehem Steel Corp., which recently announced a $300,000,000 expansion program, has awarded Koppers Co., Inc. a contract for the engineering and construction management of the steel melting and primary rolling facilities at the Sparrows Point, Md., plant.

Koppers will design and supervise construction of the following facilities:

(1) An open hearth shop with seven 350-ton open hearth furnaces and auxiliary equipment,

(2) A soaking pit shop with 16 pits of the regenerative type adaptable to blast furnace gas firing,

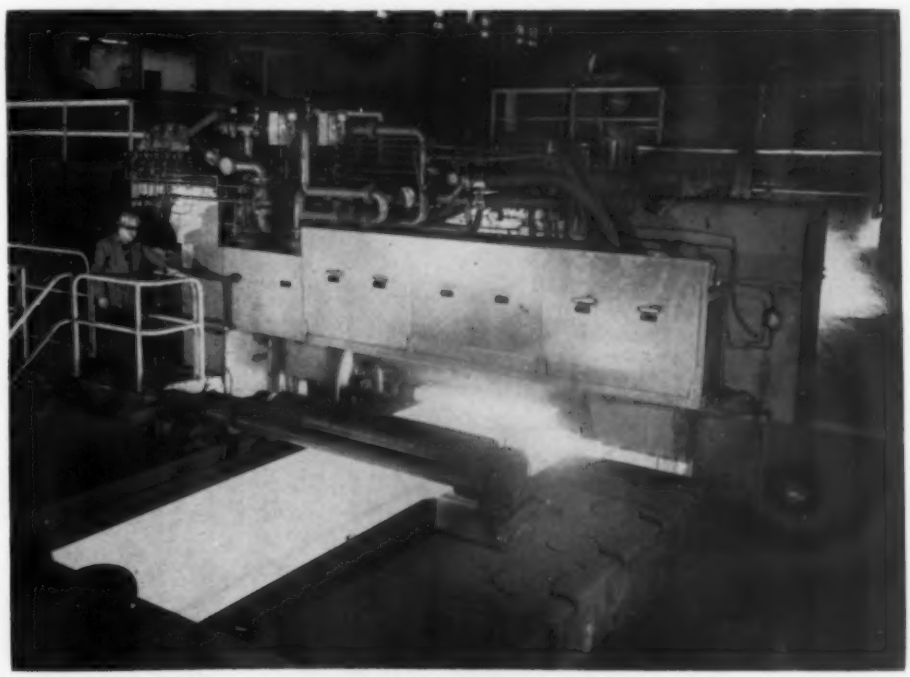
(3) A slabbing mill shop with a 45 by 90 inch universal mill, and

(4) All transportation, utility and related facilities for these installations.

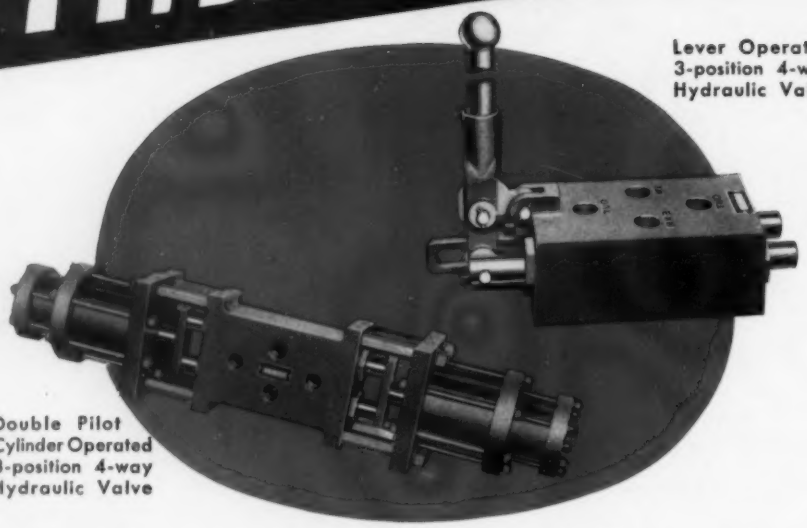
The new open hearth shop will increase the Sparrows Point plant ingot capacity by approximately 2,000,000 tons of steel per year. Included in the open hearth shop facilities are a scrap yard, stock house, material bins, ladle repair building, an ingot stripping installation, a mold yard and other auxiliary buildings and equipment. The shop can be enlarged to contain a total of 10 furnaces.

EDGAR THOMSON SCARFER USES NATURAL GAS

A hot steel slab emerges from Edgar Thomson's new slab mil scarfer with all four sides free of surface defects. Burning compressed natural gas at 5,000 degrees F, the new scarfer, first in the industry to use natural gas, assures high quality of sheets rolled from slabs produced at this U. S. Steel plant in Braddock, Pa.



Quick-As-Wink® Hydraulic Valves



Lever Operated 3-position 4-way Hydraulic Valve

Double Pilot Cylinder Operated 3-position 4-way Hydraulic Valve

Hand and Pilot-operated Types for Water or Hydraulic Oils to 5000 psi.

• Quick-As-Wink Hydraulic Control Valves meet the most exacting requirements. These valves are fully balanced in any position. Patented design includes hydraulically balanced U-packers. Packers are floated while crossing the valving ports, thus assuring long life, and expanded by internal valve pressure to provide a tight seal. Maintenance is extremely low and usually can be done quickly in the field, avoiding the delay of returning valves to the factory for servicing, or the need of maintaining large standby inventories. For long, dependable, trouble-free service, specify Quick-As-Wink Hydraulic Valves. Write for Bulletin No. 531 and the fully descriptive Data Sheets. They give complete details. Write *today!*

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CAM OPERATED SINGLE PLUNGER VALVE ⅜" to ¾" sizes. Operated by rotating cam or land on reciprocating device.

DOUBLE SOLENOID "O-TYPE" VALVE for pressures up to 125 psi. Widely used as pilot valves and for operating air cylinders.

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AIR AND HYDRAULIC
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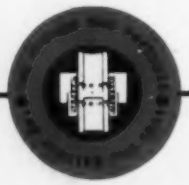


Hand, Foot, Cam, Pilot, Diaphragm and Solenoid Operated

Mfd. by C. B. HUNT & SON, INC., 1928 East Pershing St., Salem, Ohio

The soaking pits and slabbing mill will be built to handle the additional tonnage, with a large reserve for future expansion. Included in the new Sparrows Point slabbing mill shop will be facilities for slab handling and storage. The mill will be designed to take ingots from the plant's existing soaking pits, as well as from the new pits to be built.

Preliminary work has been underway for several months. Construction is scheduled for completion by the end of 1957.

TO USE WESTINGHOUSE DRIVE ON COLD MILL

▲ Westinghouse Electric Corp. has been selected by Wheeling Steel Corp. as the supplier of main drive and auxiliary electrical equipment for a five-stand tandem cold reduction tin plate strip mill to be installed at Yorkville, Ohio. This equipment will contribute to the production of tin plate in 42-in. widths at a maximum nominal delivery speed of 6000 fpm. In addition, the new mill will be suitable for the production of cold reduced strip in widths of 18 to 42 in., and in thicknesses from 0.00625 to 0.0359 in.

Individual control for the generators supplying each mill stand and the reel drive will utilize 400-cycle Magamp systems for flexibility and precision.

Installed motor hp for the five mill stands will total 21,000 hp, with individual stand motors ranging from a 2000-hp single-armature motor on Stand 1 to a twin drive on Stand 5 using two 3000-hp double-armature motors.

A 1500-hp triple-armature motor will power the reel drive.

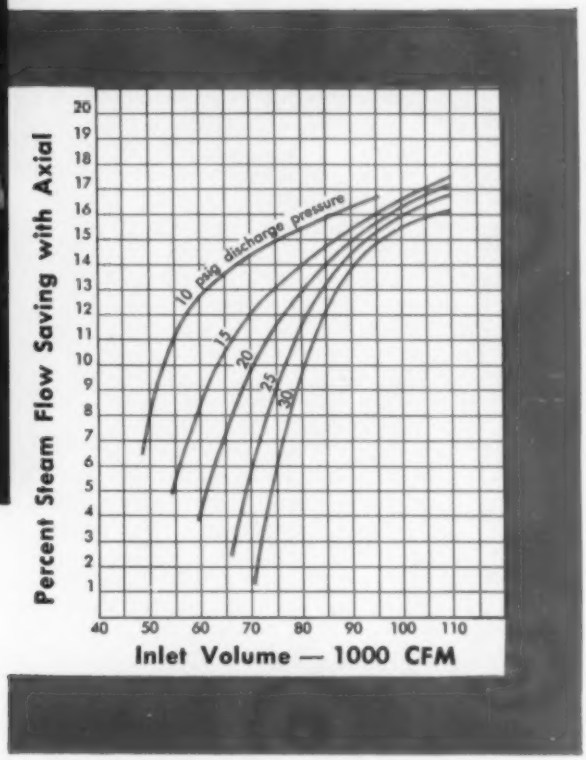
REYNOLDS ANNOUNCES EXPANSION DETAILS

▲ A $43,000,000 expansion of Reynolds Metals Co. facilities has been announced. The expenditure will increase production of the alumina plant near Corpus Christi, Texas, by more than 50 per cent and enlarge the facilities of the aluminum sheet rolling mill at Sheffield, Ala.

An estimated expenditure of between $25,000,000 and $30,000,000 will be required at the La Quinta alumina plant in Texas. It is planned to increase production of this plant to

Allis-Chalmers Axial Compressors for Blast Furnaces

Save 14-16% A Year on STEAM



In ratings over 100,000 cfm, save $50,000 to $70,000 per year on steam using Allis-Chalmers axial compressors in place of centrifugals

Here's why these savings are possible:

1 High Compressor Efficiency — A 110,000 cfm axial compressor requires 9.7% less horsepower due to inherent efficiency advantage. Air path of axial is nearly a straight line and losses from sharp turns (as in a multi-stage centrifugal blower) are eliminated.

2 High Turbine Efficiency — At 100,000 cfm and above, Allis-Chalmers axial compressor approaches optimum speed of 3600 rpm. A centrifugal blower of this rating operates at about 2600 to 2700 rpm. This higher design speed results in higher turbine efficiency—added steam flow economy for axial type.

This combination of efficiency factors means:

$50,000 to $70,000 yearly savings in steam used for the turbine drive . . . fast payoff.

In addition, the steam condenser required with an axial compressor is smaller because of lower steam requirements. Axial compressors are also smaller, easier to install. They require less floor space, smaller foundations than centrifugal blowers of the same rating.

Get complete facts. Allis-Chalmers is unbiased as a builder of both axial and centrifugal types. Call your nearby A-C office, or write Allis-Chalmers, Industrial Equipment Div., Milwaukee 1, Wis.

A-4831

A-C ALLIS-CHALMERS

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Upper: Hydraulic Press for the extrusion of tubes, sections, strip and wire from heavy, and light metals; designed with 3 tie rods for horizontal presses ranging from 630 to 3,150 m. tons.

Lower: View of transverse die shift, saw for severing the butt, and die ejector – all controlled from operator's stand.

Our new Tube and Rod Extrusion Presses

with self-contained oil-hydraulic pump drive or pressure water station

The container and stem are tooled especially for speedy exchange.

Production of extrusions having light dimensions and close tolerances is facilitated by provision of a centrally placed locking cylinder for moving the container accurately, and seating it uniformly against the die.

A novel device permits quick and accurate adjustment of the mandrel for the extrusion of hollow sections.

Life of mandrels is considerably increased by controlled inside cooling.

Speed of extrusion can be set and maintained according to individual requirements.

High production figures result from the automation of the press and its auxiliary equipment.

Existing Equipment by SCHLOEMANN

Domestic users of equipment built by Schloemann are assured of competent service - engineering, supply of genuine spare and repair parts. Call a Feller service engineer.

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more than 1,500 tons daily. Its present capacity is 1,000 tons a day.

It is planned to expend nearly $13,000,000 in expanding facilities of the company's aluminum sheet mill, which is an integrated part of its Alabama operations.

The largest single expenditure will be for a new reversing four-high hot mill, which will cost $4,866,000, including a building to shelter the equipment. Cold rolling equipment will be installed at a cost of $2,956,000.

Soaking pits will be added at an estimated cost of $1,667,000. A welded tube department is to be installed at a cost of $576,000. This provides for production of aluminum tube from sheet in a variety of sizes. Other equipment to be added at the sheet mill includes a scalper, two annealing furnaces, three roller levelers, sheet embossing machines, an enlarged production line in the cable mill, and a new shipping building. Combined cost of these items is estimated at $3,000,000.

WEIRTON STEEL AWARDS ORE BRIDGE CONTRACT

▲ A contract for an ore stockyard bridge to be erected at Weirton Steel Co. has been awarded to Heyl & Patterson, Inc.

The 10-ton bridge will join the three other ore bridges now in operation at the Weirton plant. All were designed, built, and erected by Heyl & Patterson, the first in 1926, the second in 1942, and the most recent in 1952.

NEW TACONITE PLANT READY FOR PRODUCTION

▲ All taconite production units at Reserve Mining Co.'s E. W. Davis Works at Silver Bay, Minn., are ready to turn out iron ore pellets in quantity.

The first pellets were produced at the Davis Works on October 21. As each additional unit of the plant was completed, it was put into operation, and pellets were stockpiled. The stockpile now contains 560,000 gross tons of pellets which will be shipped by ore carrier when the shipping season opens this spring.

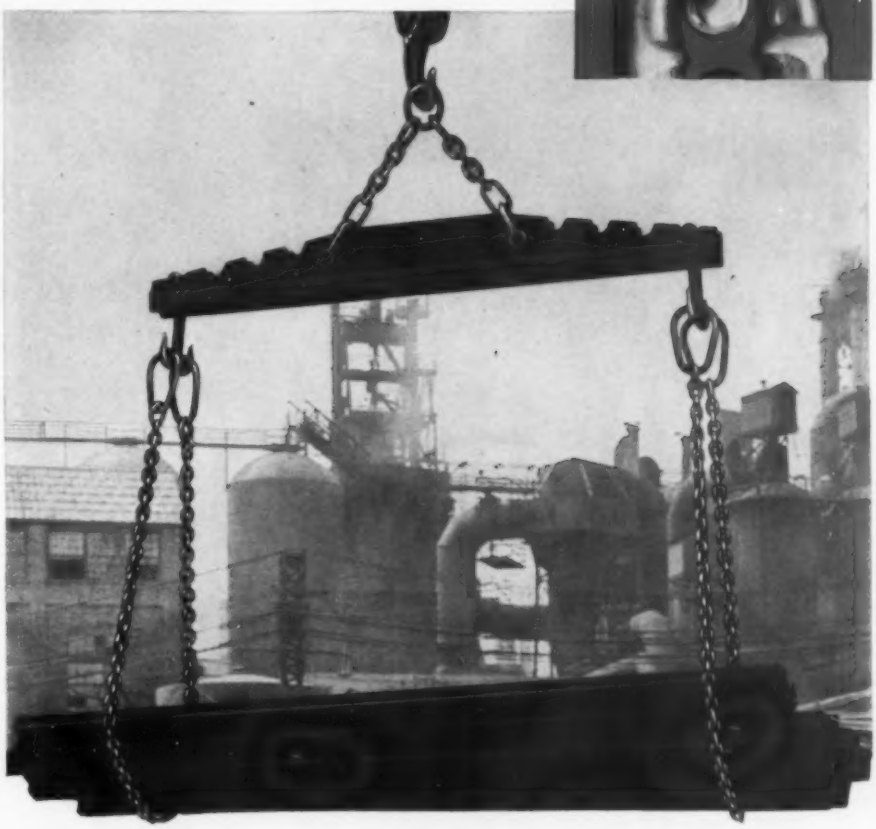
W. M. Kelley, president, pointed out that while the big construction

TAYLOR MADE

a complete line of

Alloy Steel Chain

for every industrial need



Taylor Made Alloy Chain is used in most of the nation's leading plants. It isn't coincidence. There are many good reasons. The tremendously high safety factor is one. The fact that it far outlasts other grades of chain is another. Its hardness, plus complete heat-treatment, makes it highly resistant to shock, grain-growth and work-hardness. See what Taylor Made Alloy Steel Chain can do for you. SEE YOUR LOCAL DISTRIBUTOR or send coupon today!

S. G. Taylor Chain Co., Hammond, Ind.; Pittsburgh, Pa.

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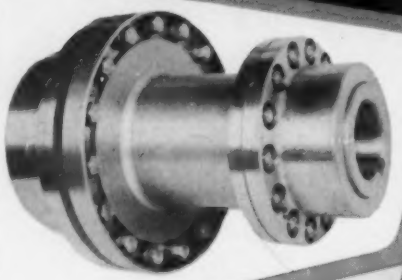
Does your problem call for a Specially Built Coupling?



Specially designed Coupling for use in a wind tunnel

WALDRON Coupling hub with special plate provides required sliding motion

then put your problem up to

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JOHN WALDRON CORP. • NEW BRUNSWICK, N. J.

Sales representative in Principal Cities

STANDARD TYPES — Waldron COUPLINGS — SPECIAL TYPES

program is virtually completed, isolated construction activities will be going on for some time. Work continues on the ore bridge which will handle pellets in stockpile and the dock loading facilities. Additional construction calls for installation of a new fine crushing line and more conveyor belts. Equipment for these projects has already been ordered.

"While all of the plant is ready to operate," Mr. Kelley said, "it is difficult to predict when our production will reach capacity level—3¾ million tons of pellets per year. Each unit of our plant has demonstrated it can produce at a rated capacity. The job now is to tune them up and make the necessary adjustments so that we can bring all of them up to full operation at the same time and keep them there.

"Few people realize that when we reach capacity operations, our mining activity will be larger than any in Minnesota, exclusive of stripping overburden. From one to one and a half ore ships will be needed each day of the shipping season to carry away all of the iron ore pellets we will make from the taconite," he said.

TO BUILD CANADIAN REFRACTORY PLANT

▲ General Refractories Co. announced plans for the building of a plant at Smithville, Ontario by its subsidiary, General Refractories Co. of Canada, Ltd. Ground will be broken and construction begun this spring.

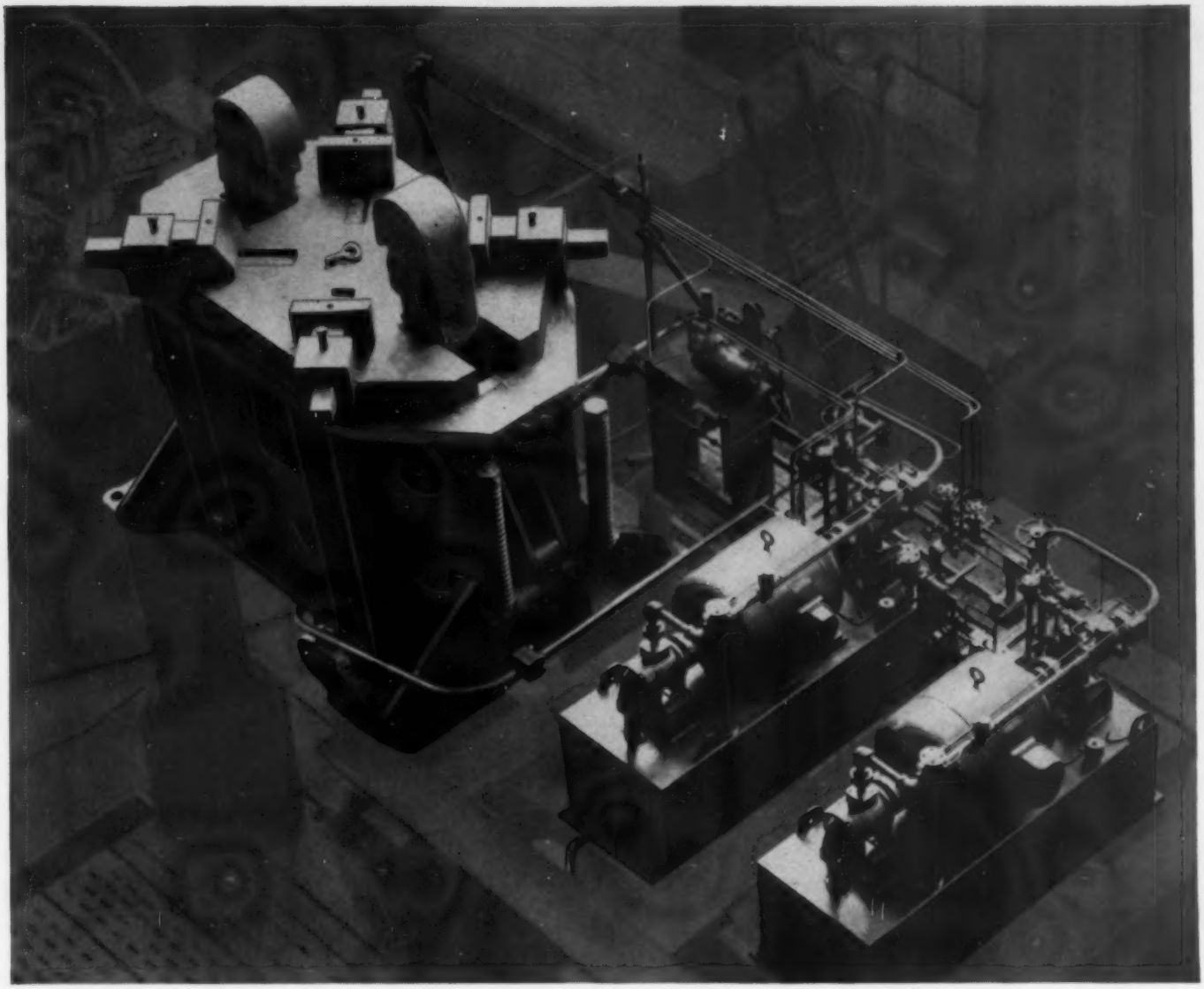
The new plant will manufacture chemically-bonded basic brick, as well as mortars, castables, and other refractory specialties. The plant will be similar to those most recently built by the parent company at Morrisville, Pa., Warren, Ohio, and Los Angeles, Calif.

Allowances have been made in plant plans for extensive expansion.

ADDITIONAL FOIL MILL EXPANSION ANNOUNCED

▲ The third aluminum foil mill expansion within a year has been announced by Aluminum Co. of America. The new expansion will locate three additional 72-in. wide foil mills at the company's Alcoa, Tenn., works.

The mill expansion, with others



BIRDSBORO designs Ingot Stripper to lock firmly, prevent mold tipping

● Check the production and cost benefits of this new 800-ton capacity Birdsboro Ingot Stripper:

1. All operations controlled by a single manual valve.
2. Locking arms lock the mold firmly against the stripping plate.
3. Compensates for all irregularities in the stripping lugs on the mold.
4. Design prevents tipping of the mold and bending or breaking of the stripping pintle.
5. Full 18″ stripping stroke takes only 17 seconds.
6. Dual hydraulic system permits operation with one pump at half speed.

This same Birdsboro engineering ability can be applied to your operations to give more efficient production.

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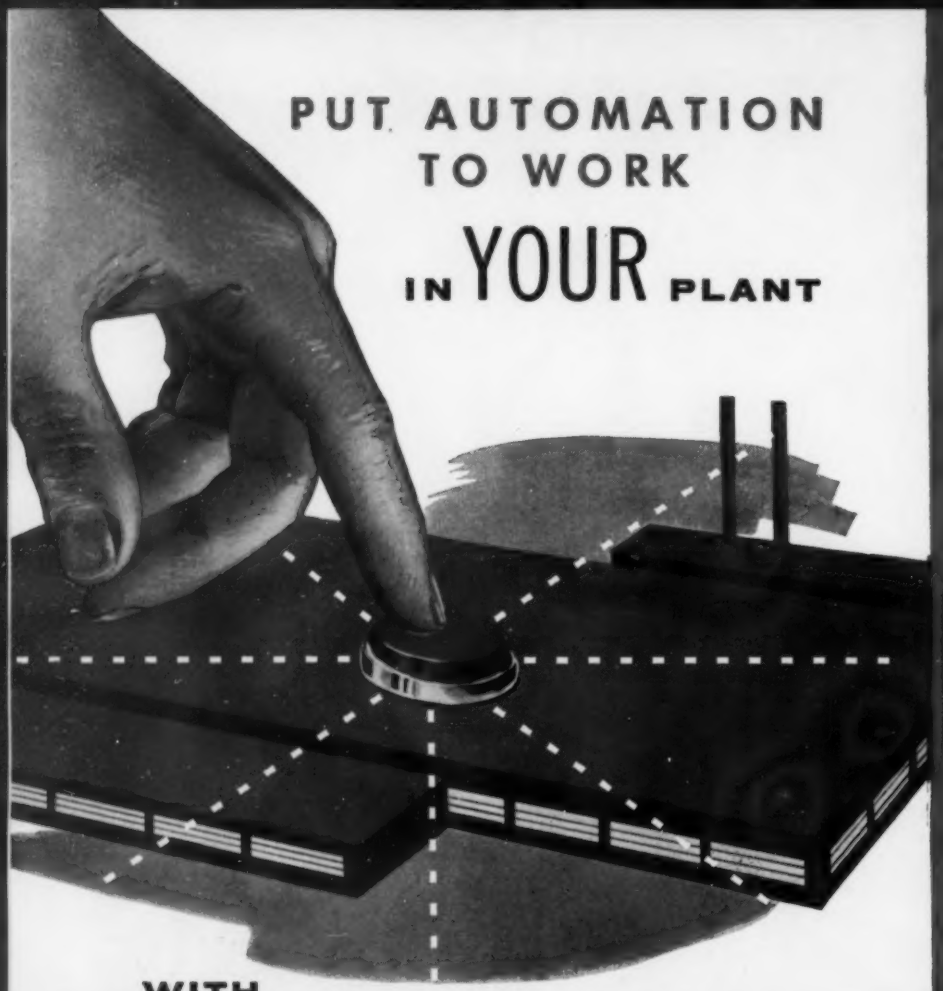
BIRDSBORO STEEL FOUNDRY & MACHINE CO., BIRDSBORO, PENNA. Offices in Birdsboro, Pa. and Pittsburgh, Pa.



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completed or started within the past year, will more than double Alcoa's foil producing capacity. Altogether, foil mill installations scheduled since early 1955 bring the company's additional investment in this single type of facility to $27,000,000.

Early in 1955 Alcoa stepped up foil output by beginning production on four new 50-in. mills at the company's Edgewater, N. J., works. Last August, eleven more mills were purchased. Of these, eight are being installed at the Davenport, Iowa, works, and three at Alcoa, Tenn. All are approaching the production stage.

The three mills announced today should be operating at capacity before the year-end to help meet a domestic foil demand presently in excess of 200,000,000 lb annually.

CF&I AWARDS CONTRACT TO GAS MACHINERY CO.

▲ The Colorado Fuel and Iron Corp., Wickwire Spencer Steel Division, has awarded a contract to The Gas Machine Co. to install a 50 ft air patenting furnace and 26 ft lead quench pan for their Buffalo, N. Y., wire mill.

ANNOUNCES OPENING OF LOS ANGELES PLANT

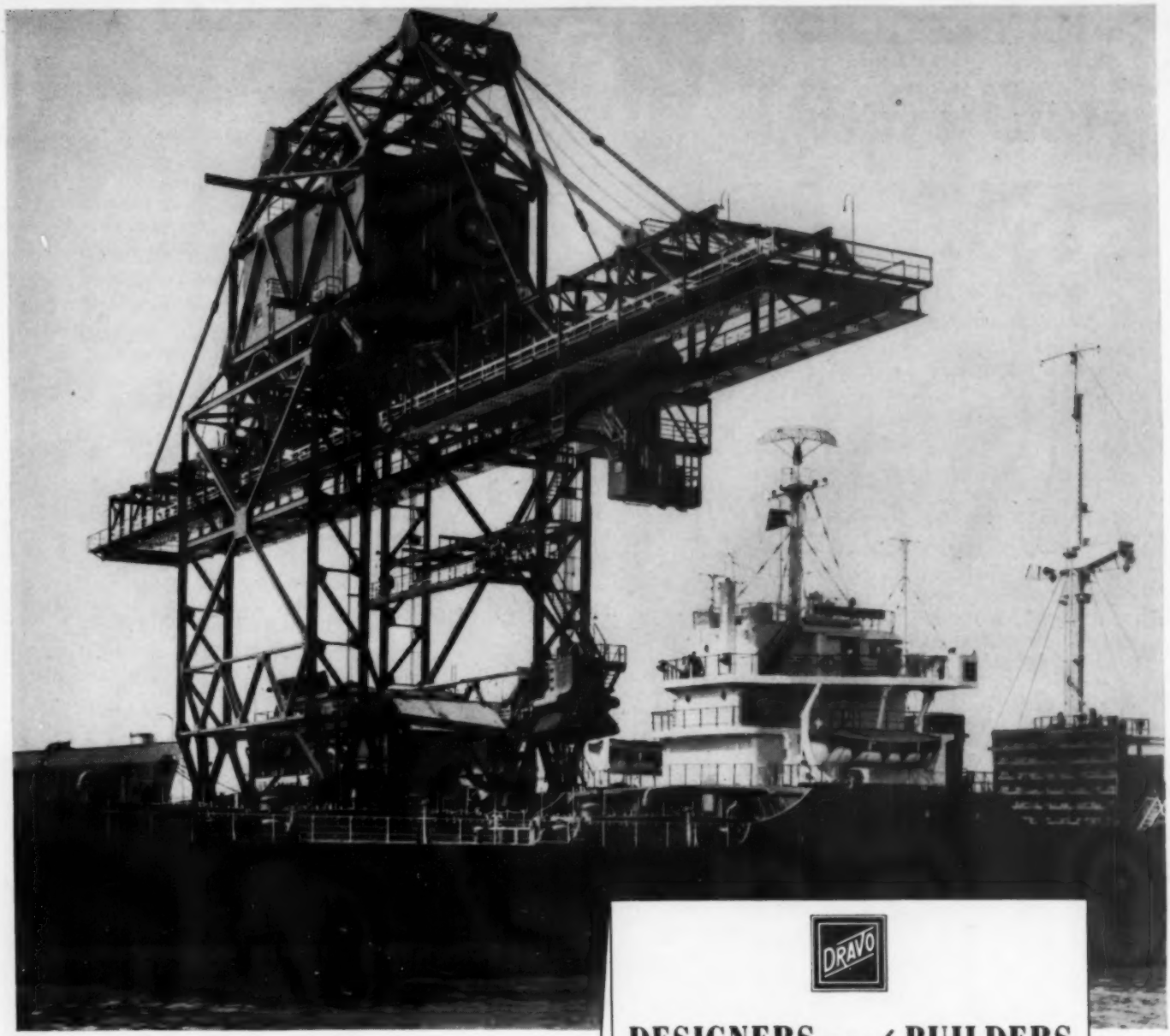
▲ Cutler-Hammer, Inc., has announced the completion of a new plant in Los Angeles, Calif. The new building will house manufacturing and warehousing facilities and the firm's Los Angeles district sales office.

The plant is located on a three-acre tract of land near the Santa Ana Freeway, eleven miles from downtown Los Angeles, and contains 31,000 ft of floor space, 4,000 of which have been designed to house the district sales offices.

Meetings

The 38th Annual Meeting of the American Zinc Institute will be held at the Hotel Statler, St. Louis, Mo., April 23 and 24.

The 10th Western Metal Congress and Exposition will be held in Los Angeles, Calif., March 25-29, 1957. The congress will be in the Ambassador Hotel, the exposition in Pan-Pacific Auditorium.



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MODERNIZED TROLLEYS FOR EXISTING BRIDGES

25 tons in one bite!

This rugged ore unloader operates around-the-clock at Pennsylvania Railroad's Greenwich Point pier in Philadelphia. To handle the huge tonnage of incoming ore, the heavy-duty machine uses an adjustable voltage system for maximum horsepower output and fast handling cycles. For Pennsylvania Tidewater Dock Company pier operators, this machine provides fast, smooth handling and increased capacity. This performance led to the ordering of a second Dravo-built ore unloader six months after the first machine was installed.

Many other users save time and trouble with Dravo-designed and built heavy materials handling equipment. You'll find this equipment at work in steel plants, power plants and at other heavy materials transfer points.

You can learn about Dravo's complete line of trolleys, bridges, towers and other related equipment by writing for Bulletin #225. Better still, let us arrange for your visit to actual installations. Simply call us at Pittsburgh, Spalding 1-1200.

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at last . . . the solution to

really tough gas-cleaning problems

Sub-micron fumes are the *really tough* problems in gas cleaning. These fumes cannot be economically or effectively controlled by conventional cleaning devices.

However, the CHEMICO P-A VENTURI SCRUBBER is proving its success in solving these *really tough* problems in more than 150 commercial installations and in more than 70 pilot investigations.

The table lists some of these commercial installations. All of these *really tough* problems and many more are being solved with complete satisfaction to users of P-A VENTURI SCRUBBERS.

PROCESS	DUST OR FUME	INSTALLED CAPACITY CFM
Incinerator—Flue Fed	Fly Ash	32,000
Incinerator—Sodium Disposal	Na_2O	9,000
Incinerator—Industrial	Radioactive Dust	6,000
Dry Ice & CO_2 Plants	Amine Recovery	72,400
CO_2 Gas for Process	Fly Ash	500
Boiler Flue Gas	Fly Ash & SO_2	4,300
Enamel Frit Furnace	Dust & HF	11,900
H_2SO_4 Concentrator	H_2SO_4	49,800
Copperas Roasting	H_2SO_4	34,250
Cobalt Ore Roasting	H_2SO_4	65,000
Chemico Wet Type Acid Plant	H_2SO_4	41,000
Chloro-Sulfonic Plant	H_2SO_4	600
Phosphoric Acid Plant	H_3PO_4	91,900
Phosphoric Acid Concentrator	H_3PO_4	194,000
Phosphor Copper Furnace	H_3PO_4	15,000
Smelting—Non-Ferrous		
Blast Furnace	Lead & Organic	12,000
Reverb. Furnace	Lead Compounds	23,500
Comb. Blast & Reverb.	Lead Compounds	7,000
Brass Furnace	Zinc Oxide	7,500
Ajax Furnace	Beryllium Fumes	4,000
Steel Plant		
Oxygen Steel Process	Iron Oxide	140,000
Blast Furnace	Coke & Iron Oxides	788,000
Zinc Sintering	Zinc Oxide	75,000
Wood Distillation	Tar Products	3,500
Na_2SiF_6 Dryer	SiF_4 & Dusts	700
Iron Chloride Concentrator	$FeCl_2$ & HCL Mist	40,000
Unknown	Carbon Black	1,700
Lime Kiln	Lime & Na_2O	18,000
Detergent Spray Dryer	Chemical Fume	250,000
Furfural Residue Burner	Fly Ash	36,000
Nodulizing Kiln	Manganese & Lead	25,000
Aluminum Pot Lines	Tar Fog, Fluorides	40,000
Carbide Furnace	Metal Oxides	1,000
Asphalt Plant	Rock Dust	80,000

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Setting machinery?

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EMBECO GROUT
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Whatever the grouting job — heavy equipment, machinery, anchor bolts, building columns, etc. — Embeco Pre-Mixed Grout will give you *lasting* results.

Embeco Pre-Mixed Grout produces a *flowable* grout that is *non-shrink* . . . insures full bedplate contact . . . maintains alignment . has high impact-resistance.

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Recommended by leading equipment manufacturers everywhere. EMBECO PRE-MIXED GROUT IS READY TO USE—you add only water. Write for 8 page illustrated booklet.

Creators and Manufacturers of Products to Improve Concrete and Mortar

THE MASTER BUILDERS CO.

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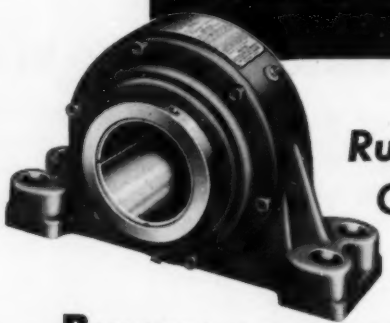
DODGE-TIMKEN

ALL-STEEL PILLOW BLOCKS



Rugged! Compact!

BEARINGS for industry's *toughest jobs.* High radial and thrust capacities. Stamina for heavy shock loads. All-steel construction that packs this load-carrying capacity into less weight and less space than ever before. A joint engineering development by Dodge and Timken. Write for Bulletin A-620 or call your local Dodge Distributor.

DODGE MANUFACTURING CORPORATION, 5900 Union St., Mishawaka, Ind.

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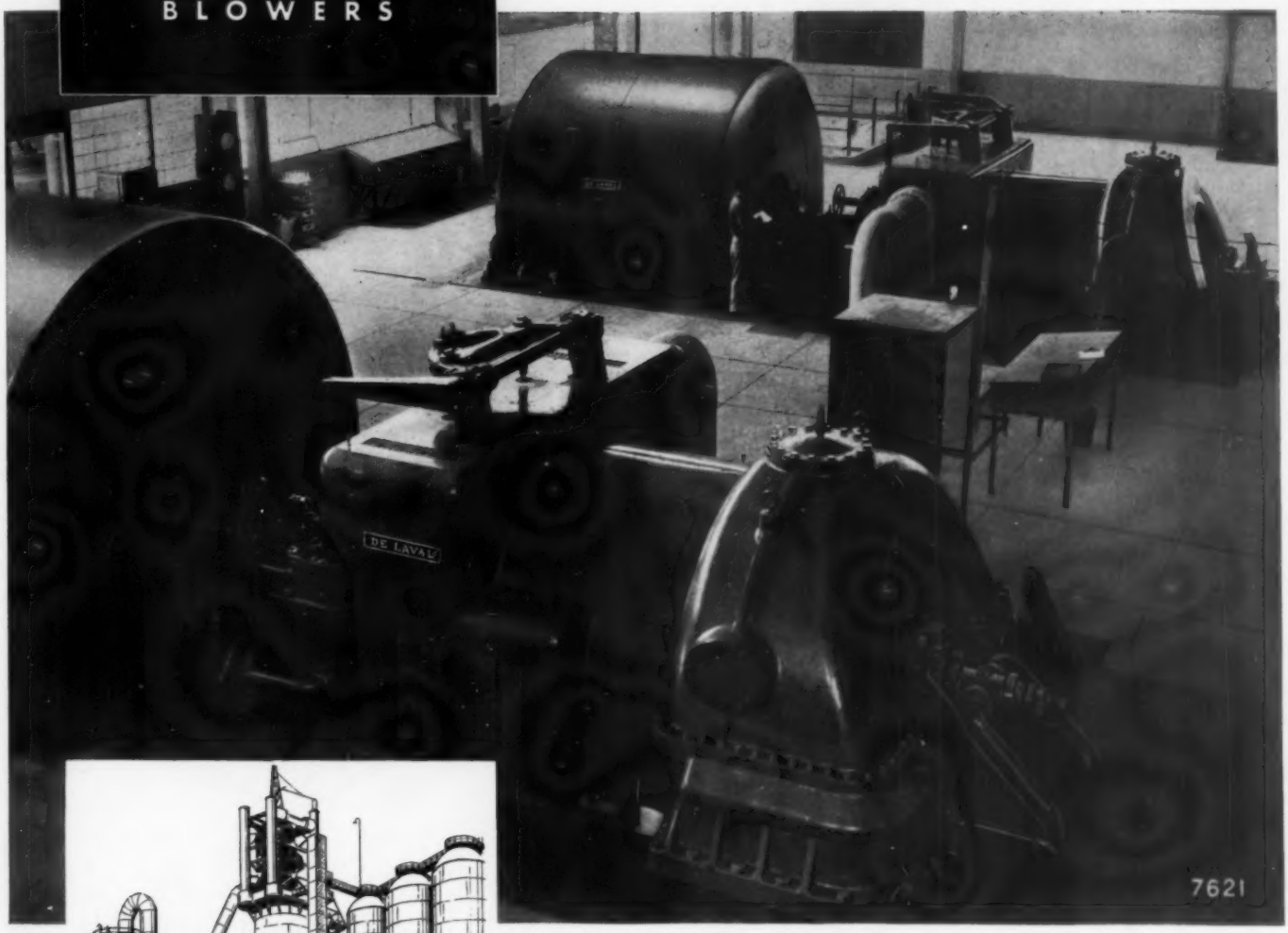
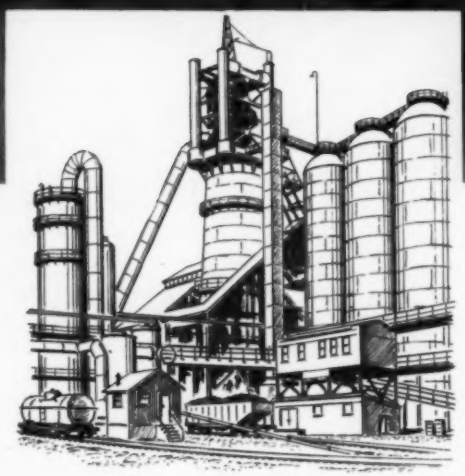
of Mishawaka, Ind.

DE LAVAL STEEL MILL BLOWERS

designed for giant furnaces





These twin De Laval blowers, on the job in a leading mid-western steel mill, are among the largest ever built. Each is a five-stage unit with a rated capacity to deliver 121,000 cfm of air at 35 psig discharge pressure. Each is driven by a 15,220 hp, 2,500 rpm De Laval 16-stage steam turbine operating under steam conditions of 400 psig, 750 F with 28 in. vac.

The total weight of each De Laval turbine and blower is over 167 tons; the blower alone is over 212,000 lbs. Shafts of the turbine and blower were made large and heavy to meet the wide range of varying speed conditions required in blast furnace service. Outside diameter of the blower casing is 12 ft. and it is divided horizontally in the plane of the shaft. This permits raising the upper half of the casing for easy access to all interior parts. • For a quarter of a century, De Laval has pioneered in advanced blower engineering designs and practices. De Laval builds single and multi-stage centrifugal blowers and compressors for service in steel, gas and coke plants. Discuss your specific applications with a De Laval Sales Engineer.

DE LAVAL *Centrifugal Blowers*

DE LAVAL STEAM TURBINE COMPANY
870 Nottingham Way, Trenton 2, New Jersey

DL 234

Let National Redesign Your Motors and Generators

Old fashioned motors and generators which can't keep up with modern demands. Electrical machines whose performance characteristics don't match changed operating conditions. Don't discard them until you check with National. Often such equipment can be redesigned and rewound to meet your new requirements for a fraction of the replacement cost.

Outmoded equipment can be rejuvenated by the introduction of modern winding techniques. Minor changes in design and materials often make a world of difference in length of life and reliability of service.

Need increased capacity from a generator? Need a motor converted to operate at a higher or lower speed? The table below shows a few of hundreds of instances in which National redesign of old equipment has saved a National customer the cost of a new motor or generator.

Write today for details, or get in touch with your nearby National field engineer.

for:

- **longer life**
- **more reliable performance**
- **increased capacity**
- **changes in voltage, speed or frequency**

Typical National Conversions To Produce New Operating Characteristics

Type of Equipment	Rating before Redesign	New Rating
Steel Mill Motor	1875 HP, 900 RPM, 2200 volts, 3 phase, 60 cycles	1565 HP, 750 RPM, 4160 volts, 3 phase, 50 cycles
Waterwheel Generator	22,223 KVA, 171.4 RPM, 11,000 volts, 3 phase, 60 cycles	27,000 KVA, 171.4 RPM, 11,000 volts, 3 phase, 60 cycles
Motor	125 HP, 600 RPM, 4100 volts, 3 phase, 60 cycles	150 HP, 720 RPM, 2300 volts, 3 phase, 60 cycles
Turbo-generator	1563 KVA, 3600 RPM, 2300 volts, 3 phase, 60 cycles	1563 KVA, 3600 RPM, 480 volts, 3 phase, 60 cycles
Induction Motor	75 HP, 3560 RPM, 220/440 volts, 2 phase, 60 cycles	75 HP, 3560 RPM, 220/440 volts, 3 phase, 60 cycles

NATIONAL ELECTRIC COIL COMPANY

COLUMBUS 16, OHIO, U. S. A.

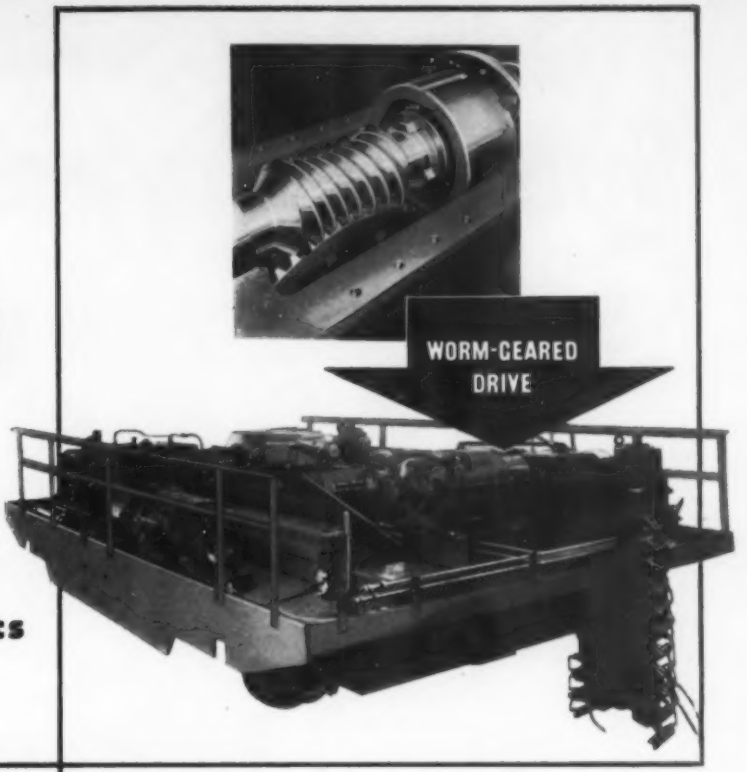
ELECTRICAL ENGINEERS: MAKERS OF ELECTRICAL COILS AND INSULATION—
REDESIGNING AND REPAIRING OF ROTATING ELECTRICAL MACHINES

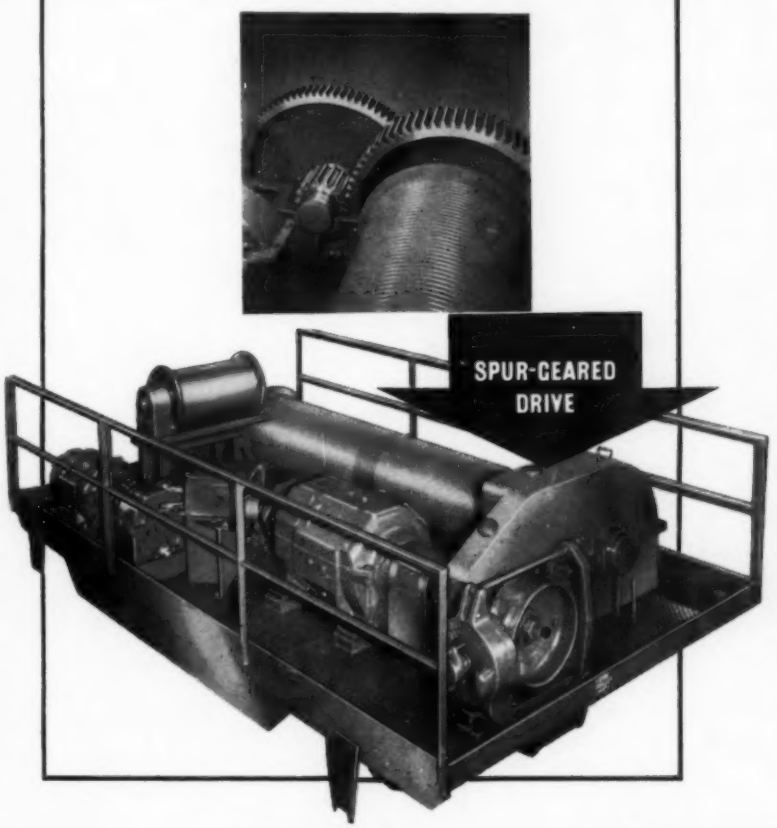
CHOOSE THE TROLLEY

YOU LIKE BEST

SHAW-BOX

Builds both to A.I.S.E. Specs





You want trolleys of the type your experience has proved are best for your particular requirements. The two types of trolleys and their gearing shown here illustrate how A.I.S.E. specifications are interpreted by Shaw-Box in satisfying the needs of two different mill applications.

Whether you prefer worm or spur gearing on your trolleys, turn to Shaw-Box and be sure of the finest in precision manufacture. Our long experience in designing, engineering and building load handling equipment exclusively assure you of continuously dependable performance, regardless of service conditions.

Over the years, we have produced many 5 to 200-ton cranes of various types to A.I.S.E. specifications and to the specifications of individual mills. Their work records prove the economic value of mechanical and operational features conceived and introduced by Shaw-Box. So if your plans include a crane to handle plate or slabs, a soaking pit carriage or a giant ladle crane, we invite your inquiry.

"Shaw-Box"® CRANES

MANNING MAXWELL & MOORE INC. TRADE MARK

MANNING, MAXWELL & MOORE, INC.

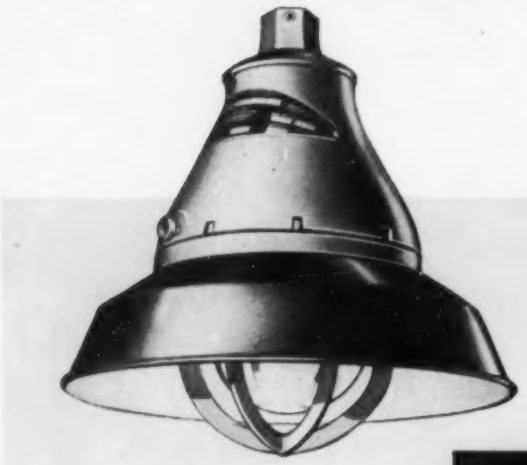
SHAW-BOX CRANE & HOIST DIVISION, MUSKEGON, MICHIGAN

Builders of "SHAW-BOX" and 'LOAD LIFTER' Cranes, 'BUDGIT' and 'LOAD LIFTER' Hoists and other lifting specialties. Makers of 'ASHCROFT' Gauges, 'HANCOCK' Valves, 'CONSOLIDATED' Safety and Relief Valves, 'AMERICAN' and 'AMERICAN-MICROSEN' Industrial Instruments, and Aircraft Products.

56K-2 A-665

COME TO CROUSE-HINDS FOR

Special Purpose Lighting...



*Condulet**

EXPLOSION-PROOF FIXTURES

for N.E. Code Class I Locations

Operate at temperatures below ignition temperatures of surrounding explosive gas-air or vapor-air mixtures. Resist internal explosions without damage. Prevent escape of flames to surrounding atmospheres.

VAPORTIGHT FIXTURES

for Class III Locations

Protect bulb, receptacle and wiring from moisture and corrosive vapors in damp locations. Enclosures are designed to prevent entrance of fibers and flyings, escape of sparks, burning material or hot metal.

COME TO CROUSE-HINDS for Free-of-Charge Lighting Help . . .

CROUSE-HINDS Engineers will survey your layouts for lighting hazardous industrial locations . . . describe National Electrical Code safety regulations . . . suggest precautions to observe . . . recommend UL-approved fixtures for each danger-area, etc.

*Trade Name Registered

Condulet

DUST-TIGHT FIXTURES

for Class II Locations

Exclude combustible dusts from interior of fixture. Even when fixture is completely blanketed with dust, temperature of fixture will not cause ignition.

Condulet

FLUORESCENT FIXTURES

Fluorescent fixtures also available for Class I, Group C and D; Class II, Groups E, F and G; and Class III.

● *Write, wire, or call your nearest Crouse-Hinds Office for complete details.*

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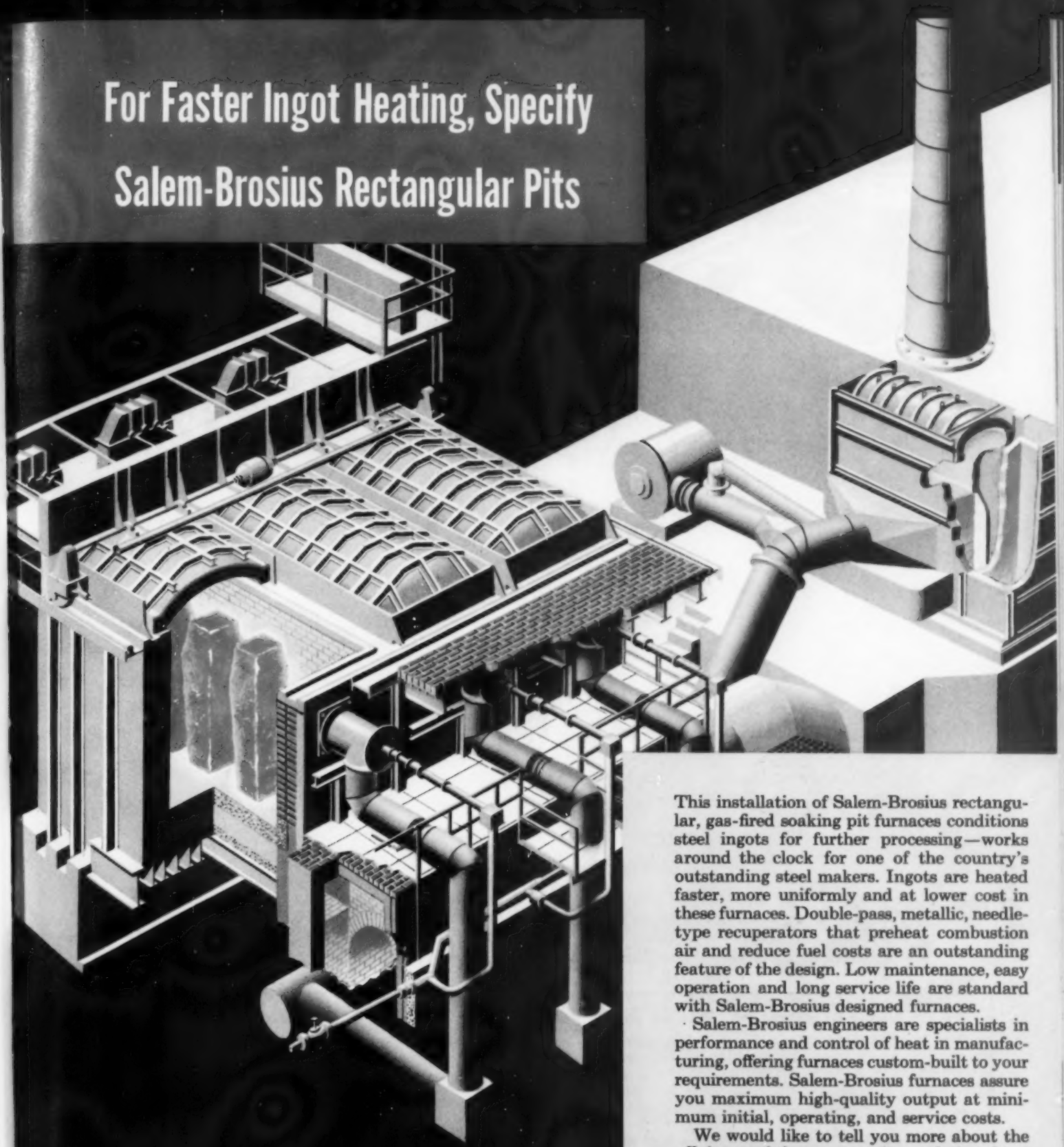
CONDULETS • FLOODLIGHTS • TRAFFIC SIGNALS • AIRPORT LIGHTING

For Faster Ingot Heating, Specify Salem-Brosius Rectangular Pits



This installation of Salem-Brosius rectangular, gas-fired soaking pit furnaces conditions steel ingots for further processing—works around the clock for one of the country's outstanding steel makers. Ingots are heated faster, more uniformly and at lower cost in these furnaces. Double-pass, metallic, needle-type recuperators that preheat combustion air and reduce fuel costs are an outstanding feature of the design. Low maintenance, easy operation and long service life are standard with Salem-Brosius designed furnaces.

Salem-Brosius engineers are specialists in performance and control of heat in manufacturing, offering furnaces custom-built to your requirements. Salem-Brosius furnaces assure you maximum high-quality output at minimum initial, operating, and service costs.

We would like to tell you more about the efficiency of these new units, and also about the well-known Salem-Brosius circular soaking pits.

If your modernization or expansion plans call for heating or heat treating furnaces of any kind, write, wire, or phone Salem-Brosius.

SALEM-BROSIUS, INC.

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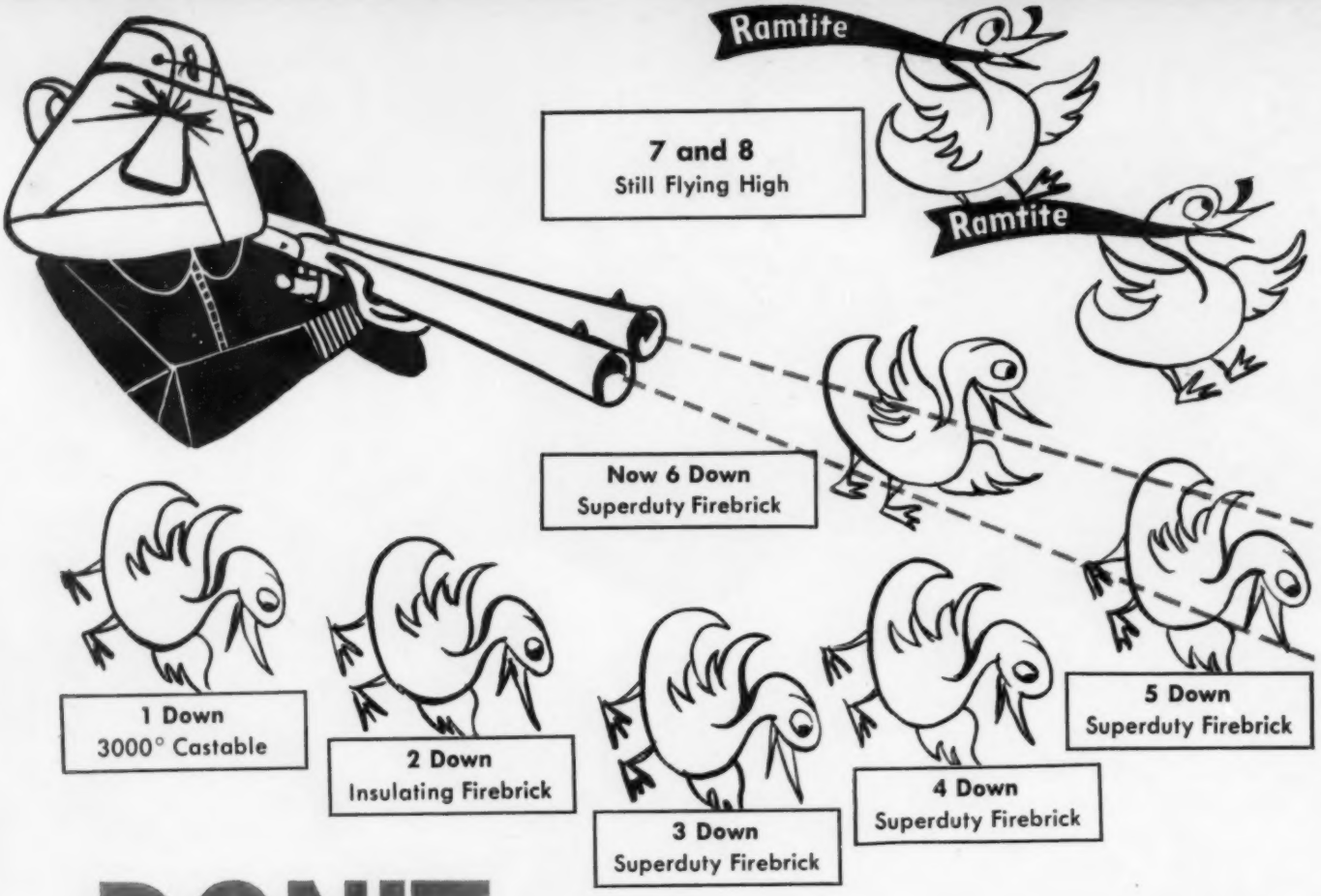


DON'T BE A DEAD DUCK!

6 soaking pit covers, lined with three types of refractories, have lived their lives.
2 Ramtite covers are still flying high.

This is the story of 8 soaking pit covers—installed in new pits—in February, 1952—in an eastern steel mill.

4 covers were—Superduty Firebrick
1 cover was—Insulating Firebrick
1 cover was—3000° F. Castable
2 covers were—Special Super Ramtite No. 25

One after another the insulating firebrick, castable and superduty firebrick failed and were replaced with Ramtite. The two original Ramtite covers are still in service at this date and with no repairs.

CAN YOU AFFORD NOT TO USE RAMTITE?

We are happy to inform you that we have an apology to make. We made a mistake.

Our DEAD DUCK ad in the January issue of Iron and Steel Engineer stated that the eight covers were installed in February, 1952.

We were wrong.

They were installed in February, 1953.

Consequently, the six dead ducks had even shorter lives than we stated.

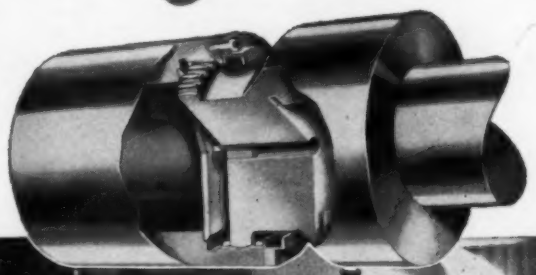
The two RAMTITE ducks are, of course, still flying high.

Ramtite is our business—not our sideline.

THE Ramtite CO.
Division of the S. Obermayer Co.
1813 South Rockwell Street, Chicago 8, Illinois

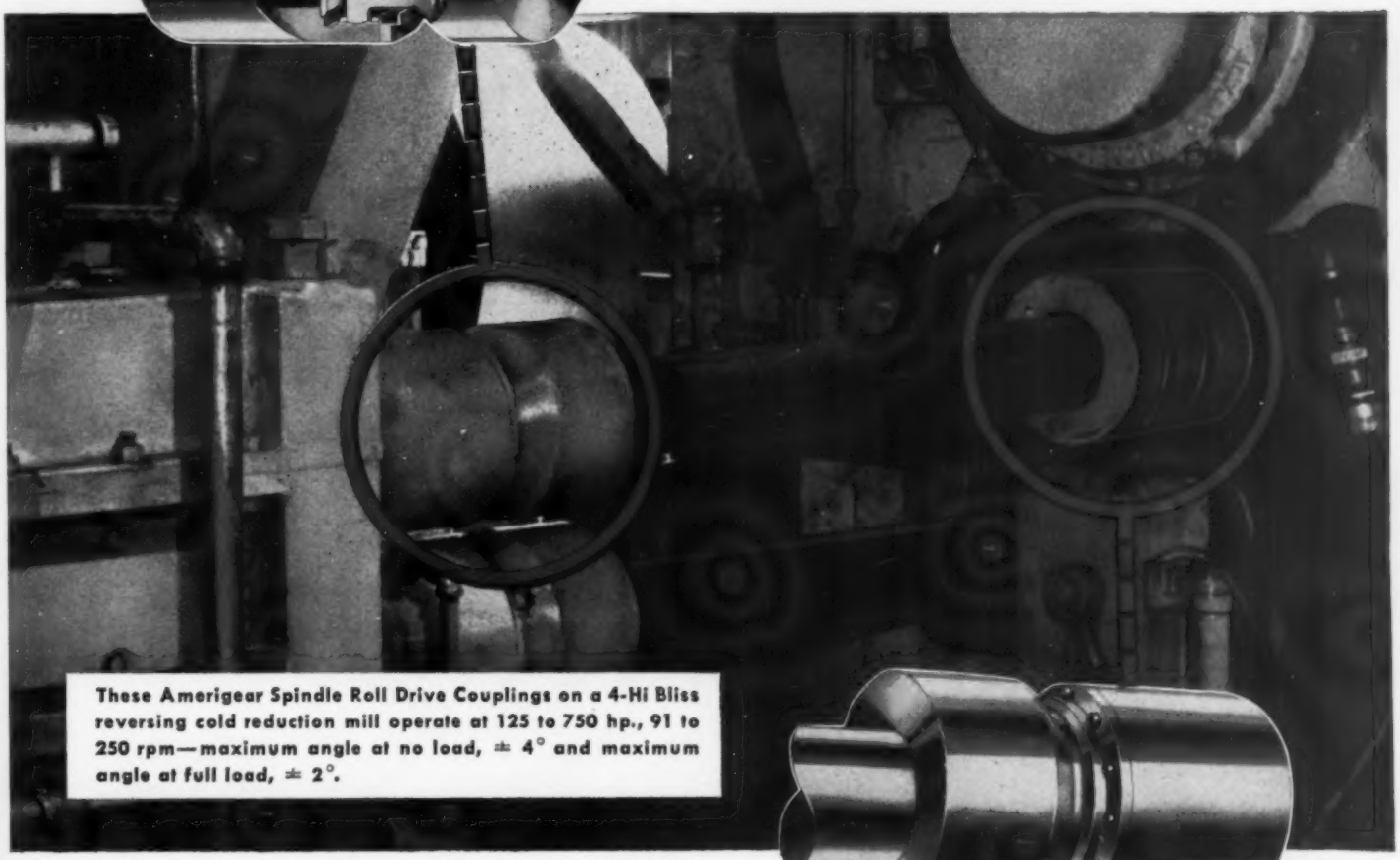
Ramtite soaking pit covers save a lot of material and work.

TROUBLED WITH "SLIPPER-TYPE" COUPLING FAILURES?
CONVERT TO
Amerigear® SPINDLE ROLL DRIVE COUPLINGS

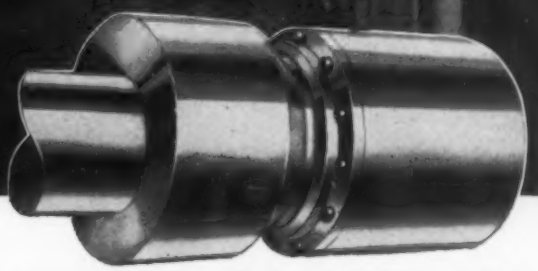


. . . RUN LONGER WITHOUT MAINTENANCE

. . . MAKE ROLL CHANGES FASTER



These Amerigear Spindle Roll Drive Couplings on a 4-Hi Bliss reversing cold reduction mill operate at 125 to 750 hp., 91 to 250 rpm—maximum angle at no load, ± 4° and maximum angle at full load, ± 2°.



• HERE'S THE ANSWER TO YOUR HIGH MISALIGNMENT PROBLEMS . . .

Amerigear's Fully-Crowned Tooth Form concentrates the load towards the center of the tooth, eliminates tooth end and tip loading. This permits an extremely high degree of angular and lateral misalignment—up to ± 9° per engagement—with no wear or loss of power.

And By Accommodating For Roll Wear and varying distances between roll centers, Amerigear Spindle Roll Drive Couplings keep your maintenance expenses to a minimum. That's because they're precision-manufactured to transmit power to the rolls smoothly and continuously . . . even after repeated roll grinding . . . *without maintenance*.

Downtime Goes Down, Too because engaging roll end teeth are specially designed for quick assembly and disassembly. So the next time you're in need of flexible couplings for your ferrous or non-ferrous rolling mills, convert to Amerigear — a highly engineered solution to your every high misalignment problem.

Amerigear Engineers are ready to help you design improved operating efficiency into heavy presses, slitters, cranes, reels or other steel mill equipment. Write for Catalog 501 and Bulletin 1052, or attach coupon below to your letterhead.

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AMERICAN FLEXIBLE COUPLING COMPANY
ERIE, PA., U. S. A.

Please send me further information regarding AMERIGEAR COUPLINGS with the Patented Fully Crowned Tooth Form as described in Catalog No. 501 and Bulletin 1052.

Name.....Title.....

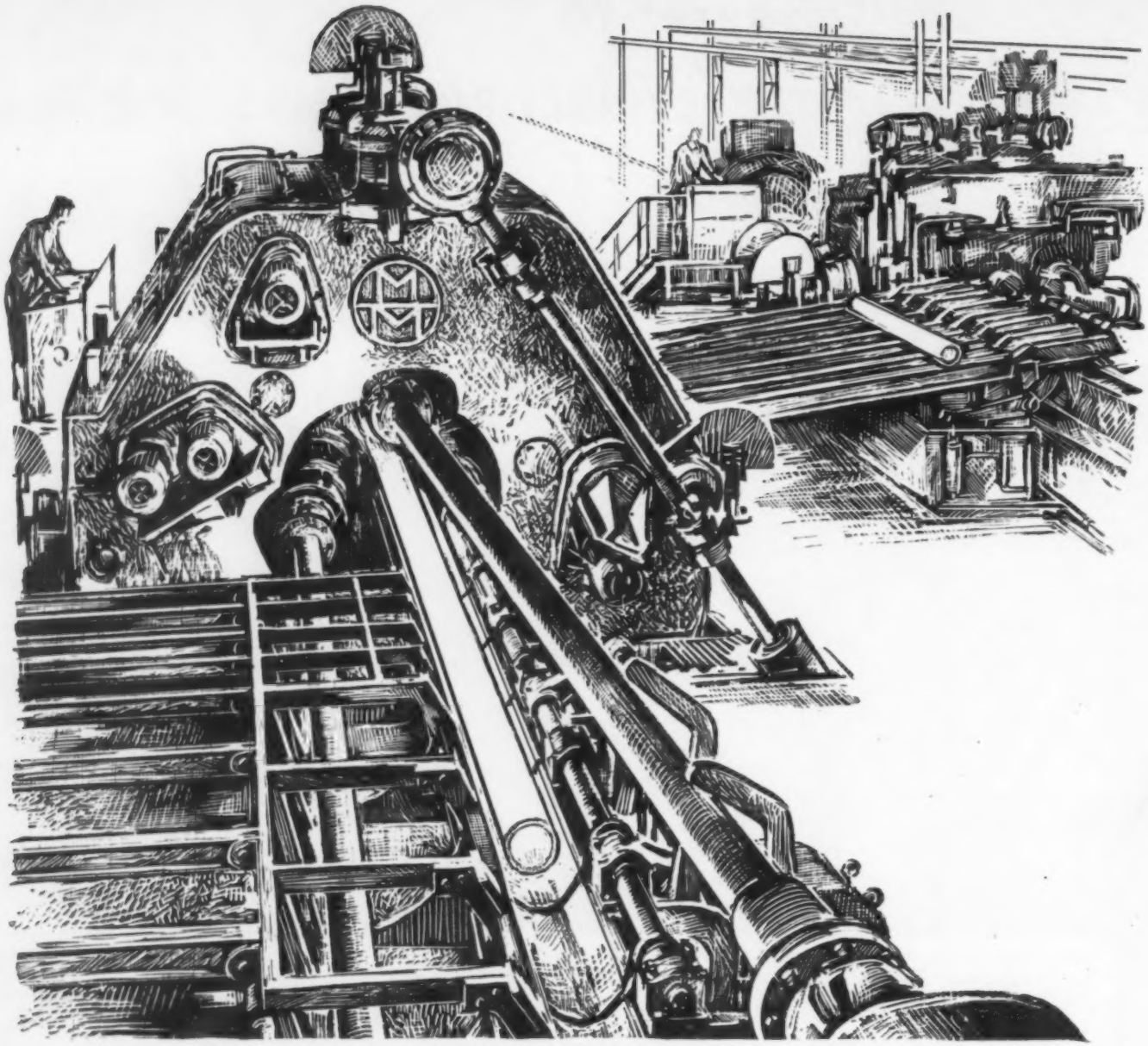
Company.....

Address.....

City.....Zone.....State.....

Please attach to your business letterhead.

Dept. ISE-999



THE WORLD'S LARGEST ASSEL MILL

This mill, recently shipped by Mannesmann-Meer, is another example of their engineering and manufacturing capabilities. Supplied to one of the world's foremost bearing manufacturers, this mill is capable of rolling up to $8^1/_2$" OD., heavy wall shells, and it has many design and operating features not available on previous assel mills.

Progressive thinking backed by over 65 years of experience in mill operating and mill design makes it possible for Mannesmann-Meer to offer you a combination of

- CREATIVE ENGINEERING
- DESIGN EXPERIENCE
- OPERATING BACKGROUND
- AMERICAN MANUFACTURING SKILL

which is available nowhere else. Call today and put us to work on your more difficult problems.

MANNESMANN-MEER

ENGINEERING AND CONSTRUCTION COMPANY, 900 LINE STREET, EASTON, PENNA

WORLD SPECIALISTS IN HIGH-SPEED TUBE MILL MACHINERY

Personnel News...

Edwin A. Booth has been appointed manager — Tubular Products Division, Jones & Laughlin Steel Corp., succeeding **C. T. Hapgood.** Mr. Booth comes to J & L from the National Supply Co., where he was employed for 27 years.

Wilbert F. Huntley, formerly superintendent of the Blast Furnace Department at Jones & Laughlin Steel Corp.'s Aliquippa Works, has been appointed to the new position of director of Blast Furnace Operations on the staff of the vice president — production. **Alfred T. Sadler, Jr.,** formerly assistant superintendent, Blast Furnace Department, will succeed Mr. Huntley as blast furnace superintendent at the Aliquippa Works.

J. Frederick Byers, Jr. has been elected executive vice president of A. M. Byers Co., and **Albert R. Frame** has been elected vice president in charge of operations. Mr. Byers has been with the company since 1937. He has been a member of the board since 1939. He was named assistant to the president in 1949 and was elected a vice president in 1954. Mr. Frame has been general manager of operations since 1954. He joined the firm in 1948, and has served successively as superintendent of the rolling mill and as assistant general superintendent of the Byers plant at Ambridge, Pa.

Gaylord B. Barnes was appointed staff assistant to the president of American Steel & Wire Division, U. S. Steel Corp. Mr. Barnes began his employment with U. S. Steel in June, 1942, when he was employed as a technical apprentice at the Wire Division's Steel and Wire Works in Donora, Pa. After successive advancements, he came to Cleveland in May, 1955, as an assistant staff industrial engineer in the general offices, the position he held prior to his latest appointment.

Edwin O. Burgham, president of Weirton Steel Co., was elected a member of the board of directors and executive committee of National Steel Corp.

Martin J. Hughes has been named mine manager of the iron ore mining operations of Kaiser Steel Corp. at Eagle Mountain, Calif. Mr. Hughes comes to Kaiser from Lone Star Steel Co., where he had been employed for seven years and was superintendent of iron ore mining and beneficiation.

David B. Carson was elected executive vice president of Sharon Steel Corp. He has served as a vice president since 1937 and is presently a director of Mallory-Sharon Titanium Corp.

Howard Cooper Johnson was appointed assistant to the chairman of the board of United States Steel Corp.

Alfred M. Goodman has been named supervisor of quality control for Acme Steel Co. Mr. Goodman came to Acme Steel recently from Inland Steel Co. where he was supervising metallurgist. He was with Inland Steel for 19 years.

Nicholas Polkabla was appointed assistant to the vice president — industrial relations, Pittsburgh Steel Co. Also, **Francis St. Clair O'Leary** has been named counsel, industrial relations, and **Edwin W. Harvey** will fill the newly created position of administrative assistant, industrial relations.

Grant H. Carpenter has been promoted to assistant to the plant manager at Jones & Laughlin Steel Corp.'s Wire-Rope Division plant at Muncy, Pa. He formerly was chief metallurgist for the Wire Rope Division. **C. T. Evenden** has been named chief service engineer. He formerly was service engineer. **W. H. Myers** has been appointed metallurgist at the Muncy plant. He formerly was a process and development engineer.

Frank J. Thomas has been appointed superintendent of steel conservation and quality control at the Cleveland plant of Republic Steel Corp. He succeeds the late **Thomas J. Woods** as superintendent of steel conservation in addition to his present duties as head of quality control. **Robert A. Saxer,** process metallurgist, has been named assistant superintendent of steel conservation and quality control. Mr. Thomas joined Republic in Buffalo in 1929, and remained there until 1935 when he was appointed chief lubrication engineer of Republic with headquarters in Cleveland. He was

EDWIN A. BOOTH

WILBERT F. HUNTLEY

J. FREDERICK BYERS, JR.

ALBERT R. FRAME

E. R. JUNG

ROBERT WHITEHILL

W. R. HECKMAN

ROBERT H. EGAN

appointed assistant superintendent of the mechanical department at the Youngstown plant, a position he held until being named superintendent of quality control at Cleveland in 1948. Mr. Saxer joined Republic at the Chicago plant in 1942 and in 1954 was appointed process control metallurgist at the Cleveland plant.

E. R. Jung, formerly vice president—sales of Clark Controller Co. has been named as vice president in charge of marketing of the company's newly-created marketing division. Also announced as part of the new organization were appointments to two major sales positions. **Robert Whitehill,** formerly assistant general sales manager, has been named general sales manager; **W. R. Heckman,** currently in the company's Cleveland district sales office, will fill the newly-created position of manager of industry sales.

Robert H. Egan was appointed division industrial engineer for Republic Steel Corp.'s Berger Division in Canton, Ohio. Mr. Egan succeeds **C. J. Russell,** who will be reassigned.

Louis P. Struble, Jr. has been elected president and director of Union Barge Line Corp., subsidiary of Dravo Corp. He succeeds **Lowell L. French,** who died Feb. 4. At the same time **F. J. Lloyd, Jr.** was named to replace Mr. Struble as general manager of the company's Keystone Division.

Robert L. Chandler has been appointed plant manager of Square D Co.'s newest manufacturing facility in Royal Oak Township, Mich.

Raymond E. Griffith has retired as vice president in charge of refractory sales and engineering of E. J. Lavino and Co. He will continue on the board of directors of the company. **Gaylord T. Stowe,** formerly assistant vice president, has been elected vice president to succeed Mr. Griffith.

William Deans, former vice president in charge of engineering, was elected vice president of I-T-E Circuit Breaker Co. **G. E. Heberlein,** manager of the company's Switchgear Division since 1950, succeeds Mr. Deans as vice president in charge of engineering. **L. H. Lipscomb** was named vice president in charge of sales. **F. G. Schmidt,** manager of the Small Circuit Breaker Division since 1950, was named manager of the Switchgear Division succeeding Mr. Heberlein. **William P. Bolger** moves from purchasing agent to manager of the Small Circuit Breaker Division.

Walter A. Cox has been appointed general manager of WW Alloys, Inc.

Rex D. Cross has been appointed to the newly created position of vice-president in charge of sales of the Laclede-Christy Division, H. K. Porter Co., Inc.

REX D. CROSS

Van H. Viot has been named vice president — employee relations, Crucible Steel Co. of America.

W. H. Mouquin has been named district manager of the Chicago office of De Laval Steam Turbine Co., and **C. C. Bray** has been appointed regional sales supervisor at the same office.

Hans W. Bluethe has been named advertising manager, Industrial Division, of Surface Combustion Corp.

Irving J. Berkman was appointed executive vice president of Follansbee Steel Corp. and **Dewey O.**

ONE OF A SERIES . . .

What makes a cylindrical roller bearing good?

The RIGHT ROLLER DESIGN and QUALITY CONTROL

The design and quality of the *rollers* play a large part in the performance of a cylindrical roller bearing. At right are some of the vital factors which must be considered.

All these factors are scrupulously controlled by the most modern precision equipment to insure maximum performance and life for every HYATT Roller Bearing. You'll find more details in HYATT General Catalog No. 150, or your nearby HYATT Sales Engineer will gladly help you choose the type best suited to your requirements. Remember, HYATT is America's *first* and *foremost* maker of cylindrical roller bearings. Hyatt Bearings Division of General Motors, Harrison, New Jersey.

GM GENERAL MOTORS

HYATT

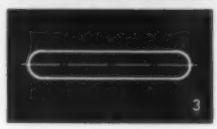
ROLLER BEARINGS

1. DISTRIBUTION OF LOAD WITHIN THE BEARING

Rollers are subjected to load only while in the "load zone," with maximum load while on the line of action of the bearing load, as shown in diagram 1. The theoretically perfect "load zone" extends from −90° to +90° from the line of action, but this is neither practical nor necessarily desirable. Under normal loadings, the actual "load zone" may range from 90° to 120°, depending on load and mounted internal clearance. This distributes the load so the load on the heaviest-loaded roller is approximately 5/N times the bearing load, where N is number of rollers.

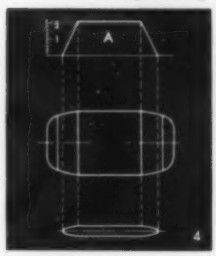
2. DISTRIBUTION OF LOAD WITHIN ROLLER'S AREA OF CONTACT

A cylinder deflects locally in the region of engagement when loaded between flat plates. The plate also deflects, so the original line of engagement is broadened into a "dog-boned" area under load, as shown in diagram 2. Moreover, deflected cylinders must gather in metal at their ends in *two planes, and this end-loading effect can seriously reduce the life of a cylindrical roller bearing.* All HYATT rollers have generous corner radii or blended chamfers to reduce end effect; and all HYATT Hy-Load rollers also have crowning to allow the contact area to "fade out" evenly (diagram 3).



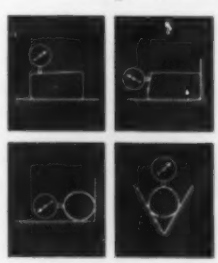
3. DISTRIBUTION OF LOAD ACROSS ROLLER

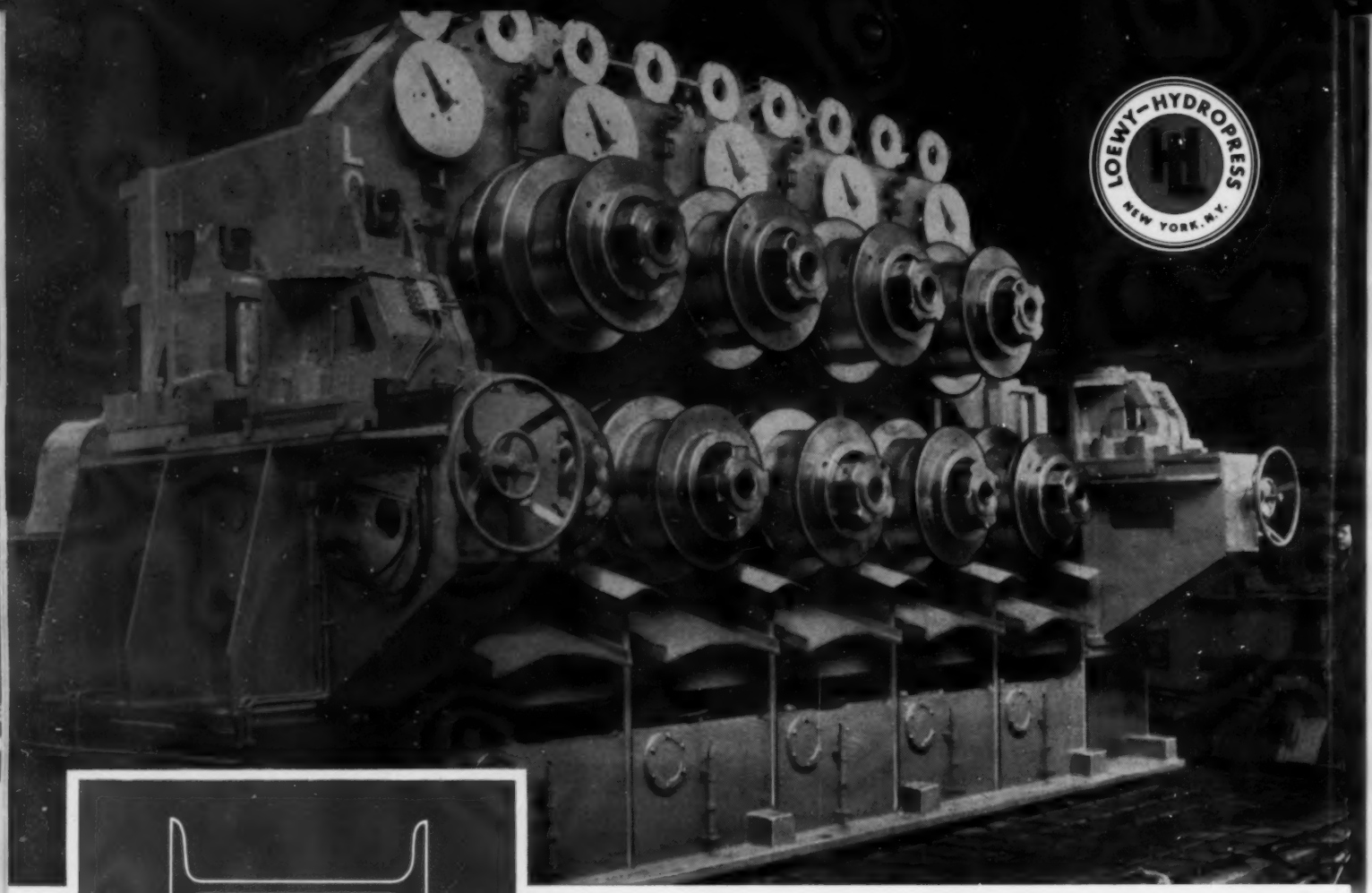
The unit load on any roller is uniformly distributed axially except at the crowned ends where it drops off to zero as shown in diagram 4. The summation of unit loads represented by area A is the total roller load. This same load under misalignment results in an area equal to area A; but maximum unit load is considerably greater and the bearing will have a shorter life than a properly aligned one. When the same total load is applied to an *uncrowned* roller, an even higher unit load results. This demonstrates the value of crowning when misalignment occurs.



4. EFFECT OF ROLLER QUALITY ON BEARING PERFORMANCE

Lack of roller quality control has a very adverse effect on performance: 1. A roller with excessive *taper* tends to uneven load distribution and abnormal temperature rise. 2. A roller with excessive *end square* tends to noisy bearing performance. 3. A roller with excessive *two-point out-of-round* tends to poor segregation and poor bearing life. 4. A roller with excessive *three-point out-of-round* tends to noisy bearing operation. 5. A roller with *poor finish* tends to wear on all operating surfaces and noisy operation. 6. A bearing with excessive *roller-to-roller diameter variation* tends to poor bearing life. 7. A bearing with excessive *roller-to-roller length variation* tends to poor thrust capacity, abnormal temperature rise.





new LOEWY roller straightener produces more tonnage to closer tolerances

Structural sections, sheet pilings, wide flange beams and heavy rails can be straightened to tolerances well above commercial standards with the new 1956 Loewy roller straightener. This efficient machine operates at speeds up to 500 FPM, and its production capacity is high, i.e. 20 lb. beams can be straightened at the rate of 1,320 tons per 8 hour shift and 73 lb. beams at the rate of 2,200 tons per 8 hours.

Other advantages you get with this new Loewy straightener are:

- **All welded rigid construction.**
- **Anti-friction bearings throughout.**
- **Motor driven, power operated vertical rollers supported on both sides in roller bearings.**
- **Remote control of vertical and horizontal roll adjustment, with accurate selsyn indicators mounted conveniently on pulpit.**
- **Quick roll changing.**

Loewy roller straighteners are in use in modern steel mills in the United States and abroad. The new model 1956 offers so many advantages over earlier designs that it is truly "*the design of tomorrow . . . today*." For more information about this precision equipment, write to us at 350-G Fifth Avenue, New York 1, N.Y.

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BALDWIN-LIMA-HAMILTON

DIVISIONS: Austin-Western • Eddystone • Electronics & Instrumentation • Hamilton • Lima • Loewy-Hydropress • Madsen • Pelton • Standard Steel Works

Olson was appointed vice president in charge of mill operations.

Ralph R. Brown has been appointed works manager and **Ernst A. Siemssen** has been promoted to superintendent of erection of Selas Corp. of America.

RALPH R. BROWN

John P. Roche was elected president of Heppenstall Co. to succeed **R. B. Heppenstall,** who was elected chairman of the board. Mr. Roche joined Heppenstall in 1946 as vice president and general manager of sales. He was elected executive vice president in 1951. Mr. Heppenstall started with the company in 1925, and became production manager in 1927. He was elected vice president in 1929, vice president in charge of sales in 1933, and president in 1939. In addition, **J. A. Succop** was elected vice president in charge of metallurgy, **Edwin Trembath** treasurer, and **R. L. Ritenbaugh** secretary.

John W. Anne, vice president in charge of headquarters application engineering for Elliott Co., is now responsible for manufacturing operations for the Jeannette Division of the company, including the Crocker-Wheeler industrial motor division. Mr. Anne joined Elliott in 1925. He became manager of the condenser department, and later manager of heat transfer and turbine sales. He was appointed sales manager of the Jeannette Division in 1948, and in 1954 became a company vice president.

H. H. Haaland was appointed chief of the Precipitator Engineering Division of Western Precipitation Corp. He replaces **D. H. Wheeler,** resigned. In his new duties Mr. Haaland will be in charge of design and engineering for the company's Cottrell Electrical Precipitators.

John E. Decker has joined the Green River Steel Corp. as night superintendent. Mr. Decker was formerly associated with United States Steel Corp., and National Forge and Ordnance Corp.

Joseph N. Gaus was appointed hydraulic engineer of Mannesmann-Meer Engineering and Construction Co., Inc. In addition, **Joseph Piperata** and **Rean L. Nolf** were named field engineers.

Edwin A. Yeo, formerly sales manager at the Pittsburgh office of Leeds & Northrup Co., has been named manager of the Chicago office. **Willard H. Neu,** formerly manager at Cincinnati, advances to manager at Pittsburgh. **Manley S. Nolen,** formerly a sales field engineer at Pittsburgh, becomes manager at Cincinnati. **Thomas C. Bennett,** formerly manager at Chicago, moves to the position of a technical assistant for resale at Philadelphia.

Carl Haugh has been named district sales manager for rolling mill equipment of the Loewy-Hydropress division of Baldwin-Lima-Hamilton Corp.

Henry M. Heyn, a vice president of Surface Combustion Corp., has been appointed general manager in charge of all functions of the Toledo Industrial Division. **Carroll Cone,** recently named chief engineer, assumes full responsibility for all engineering activities. **Donald Beggs,** formerly assistant research director, has been appointed manager of research and development. **G. J. Langenderfer,** formerly assistant sales manager, has been appointed sales manager of the Heat Treat Division. **W. M. Hepburn,** vice president in charge of engineering; **C. B. Phillips,** vice president in charge of

JOHN P. ROCHE

R. B. HEPPENSTALL

J. A. SUCCOP

JOHN W. ANNE

DALE ORR

PAUL W. BECKER

C. RICHARD SWORD

W. B. HEINZ

sales; and **E. G. de Coriolis,** research director, have been appointed to the staff of the president and will handle general assignments, including consultation, forward planning, patents and communications between plant divisions.

Dale Orr has been appointed Pittsburgh district manager of Steel Plant Equipment Corp., replacing **B. Robert Terrick.**

Paul W. Becker has joined Rockbestos Products Corp. as vice president in charge of manufacturing.

C. Richard Sword has been appointed manager of sales of Aerovent Fan Co., Inc., replacing **James F. Tilton,** resigned. Mr. Sword joined Aerovent in 1951 and has served as assistant manager of sales since 1952.

W. B. Heinz was named chief engineer of the Askania Regulator Co. He was formerly owner of Heinz Engineering Co. which was acquired by Askania.

John J. Wilber has been appointed manager of Bailey Meter Co.'s Cleveland district sales office. He succeeds **C. C. McClelland** who has retired.

C. E. Pritchard has been temporarily relieved as superintendent of mills at Alan Wood Steel Co., and assigned on a temporary basis to make a long range planning study of a wide strip mill. **D. R. Mathews** has been relieved as open hearth superintendent and assigned to study the best way of increasing and improving steel-making facilities at Alan Wood. Also temporarily relieved is **E. J. Welsh,** blast furnace superintendent, who will make a study on increasing the company's blast furnace capacity.

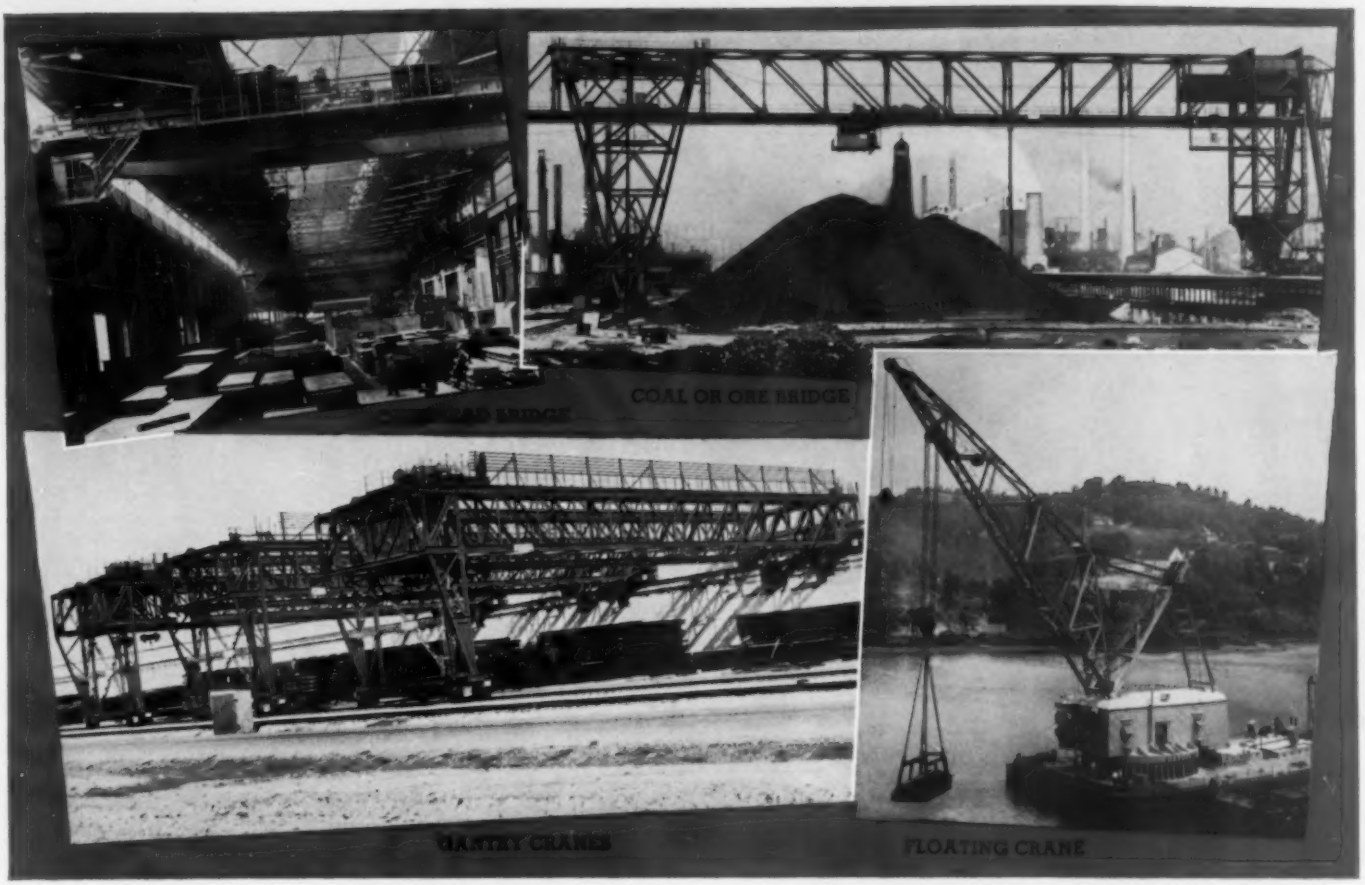
Howard U. Herrick, president of E. W. Bliss Co., has been elected to the newly-created office of chairman of the board, in which position he will serve as chief policy officer of the company. **Robert Potter,** formerly executive vice president, was elected president and chief administrative officer of the company succeeding Mr. Herrick. Mr. Potter also was elected a director and a member of the executive committee succeeding **J. H. Tredinnick.** Mr. Tredinnick, who has resigned as an executive vice president, director and member of the executive committee, will remain as a vice president and as a consultant to the president.

HOWARD U. HERRICK

ROBERT POTTER

John D. Fess has been appointed district manager of the Pittsburgh office of the Okonite Co. Mr. Fess was formerly northwest manager with headquarters at Portland, Ore. **James B. Caldwell,** who had previously

CLARK CRANE CONTROLS



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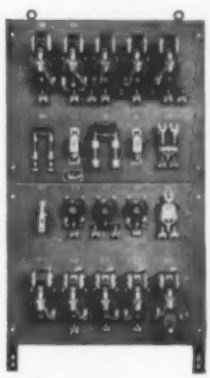
Of the many outstanding performance, maintenance and safety features built into CLARK Crane Controls, three are especially important:

1. The VARI-TIME PRINCIPLE. Smooth, rapid "definite-time" acceleration is achieved by the famous CLARK VARI-TIME core, guaranteed trouble-free for the life of the equipment. This is built as an integral part of the "RT" contactor for the ultimate in simplicity, or furnished with the "VT" relay—a relay built like a contactor. It greatly simplifies the circuits.
2. The CLARK Plugging Relay used on the Bridge and Trolley Control is completely foolproof, and cannot get out of adjustment. It prevents equipment abuse and eliminates needless use of the foot brake.
3. The CLARK Hoist Control features a circuit designed and interlocked to prevent opening of the armature-series-field circuit for protection during lowering.

Many additional features contribute to fast, dependable performance and consistent, trouble-free service.

Typical CLARK Crane Hoist Control Panel.



If you have a crane control problem, consult your nearest CLARK representative or write us direct.

The **CLARK CONTROLLER** *Company*

Engineered Electrical Control

1146 East 152nd Street ▪ ▪ Cleveland 10, Ohio

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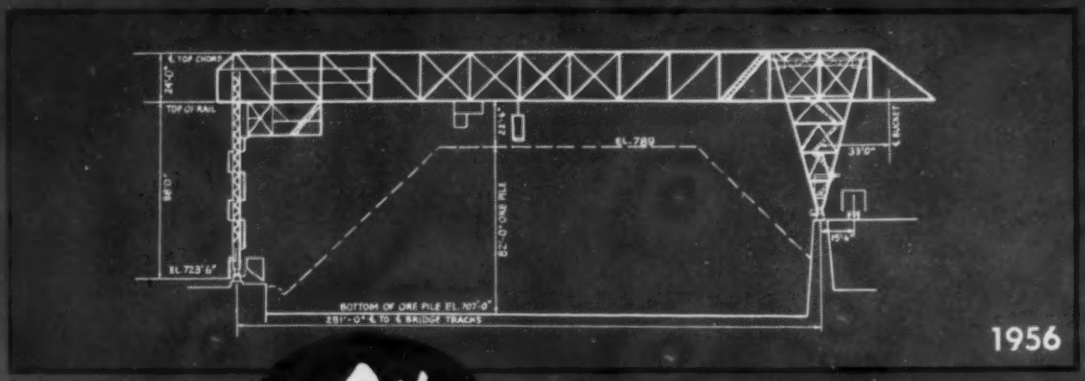
UP GOES PRODUCTION AT WEIRTON STEEL COMPANY . . .

Division of National Steel Corporation



1956

and UP goes the 4th Heyl & Patterson Ore Bridge

3rd 1952

2nd 1942

1st 1926

Any equipment that contributes to increased production by National Steel's Weirton Steel Company division must be time-tested for dependable performance.

In 1926 (30 years ago) Heyl & Patterson built Ore Bridge No. 1 . . . in 1942 Ore Bridge No. 2 . . . in 1952 Ore Bridge No. 3. All three Ore Bridges are in successful operation. Now . . . Ore Bridge No. 4 is being built by Heyl & Patterson to accelerate the ever-mounting steel production records of Weirton Steel Company.

Wherever Ore and Coal Bridges are essential to consistent, time-tested production you can depend upon Heyl & Patterson Engineering, Fabricating, and Erection. Having an H & P Authority on Ore Bridges consult with you involves no obligation.

Heyl & Patterson
INC.

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been assigned to the Los Angeles office, will assume the position of branch manager at Portland, while **Edwin R. Conklin,** of the Portland staff, will become branch manager at Seattle.

Herman F. Kaiser has been named superintendent of the blooming mill at Republic Steel Corp.'s Canton, Ohio, steel plant. He succeeds **Ben C. Wells,** who died recently. Mr. Kaiser has been assistant superintendent at the blooming mill since 1954. He joined Republic in 1928 and has held a variety of supervisory positions at the Canton steel plant.

John J. Coffey has been named district sales engineer in charge of Thermal Research Corp.'s newly established New York office.

James L. Everett was appointed assistant to the general manager of Dravo Corp.'s Engineering Works Division.

A. C. Meixner has been named sales manager of the Westinghouse Electric Corp.'s transportation and generator division, East Pittsburgh, Pa. Mr. Meixner succeeds **J. B. Walker** who has been transferred to the company's Pittsburgh headquarters as sales manager of apparatus products.

H. B. Alford was promoted to chief field engineer of Western Precipitation Corp.

Richard S. Rhodes, assistant manager, production department of Koppers Co., Inc. since 1954, has been named assistant to the president. In the newly-created position Mr. Rhodes will assist the president with special responsibility for developing policies and methods for handling and evaluating the company's capital program and capital appropriations. He also will serve as permanent secretary of the company's appropriations committee and as a voting member of that committee.

Obituaries

John M. Sylvester, general manager of the Bethlehem, Pa., plant of Bethlehem Steel Co. since 1945, died February 28. He was 65. Mr. Sylvester joined Bethlehem Steel in 1914. He was appointed assistant manager of the Bethlehem plant in 1936 and manager in 1945.

Arthur Glenn McKee, one of the pioneers in the blast furnace field, and founder of the company which bears his name, died February 19.

William J. Harper, who was employed for nearly 40 years by Republic Steel Corp. and predecessor company in engineering and executive capacities, died March 2. He was 62. Mr. Harper was chief combustion engineer of Republic prior to January 1 when he retired due to ill health. He held that position ever since the formation of Republic by the merger of several independent steel companies in 1930. He maintained his office at Youngstown from 1930 to 1935 and came to Cleveland when Republic's general offices were moved there in 1935.

NEW

Model Aire-Rectifier

by LINTERN

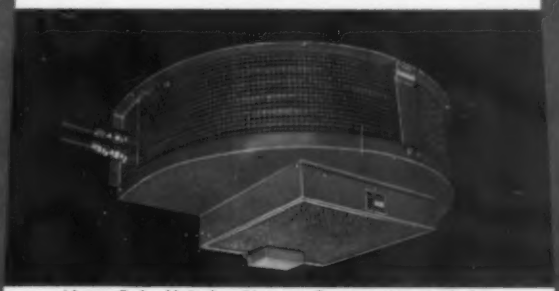
offers many improvements

Eliminated entirely are the copper refrigerant lines. This means also the elimination of soldered joints — about 30 on the average installation. We have replaced these copper lines with high pressure hydraulic hose especially designed for **Freon** refrigerants. Hose connections are high quality **Hoze-Lok** fittings.

Advantages are many, such as (1) elimination of vibration problems, (2) avoidance of leaks, (3) reduced installation time and (4) quick disconnection of any part for service.

NEW

Combination Cooling Unit



New Cab Unit by Lintern Corporation includes cooling, electric heating and complete air filtering.

Another noteworthy development is the new Cooling (Cab) Unit which can be located on ceiling or placed on floor, depending on headroom requirements.

Since this new unit is for pulpits as well as crane cabs, it offers users the advantages of standardization with consequent reduction in service parts.

The filters can be changed by simply slipping them out — without removing the service panel. The mechanical filter — **Pliotron** — is easily cleaned. The activated carbon filter is of the permanent type which can be reactivated. All this sets a new record for ease of service and low cost maintenance.

Write for new Bulletin 561 just issued, full of helpful information.

Larco, inc.

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GENERAL ELECTRIC *Control*

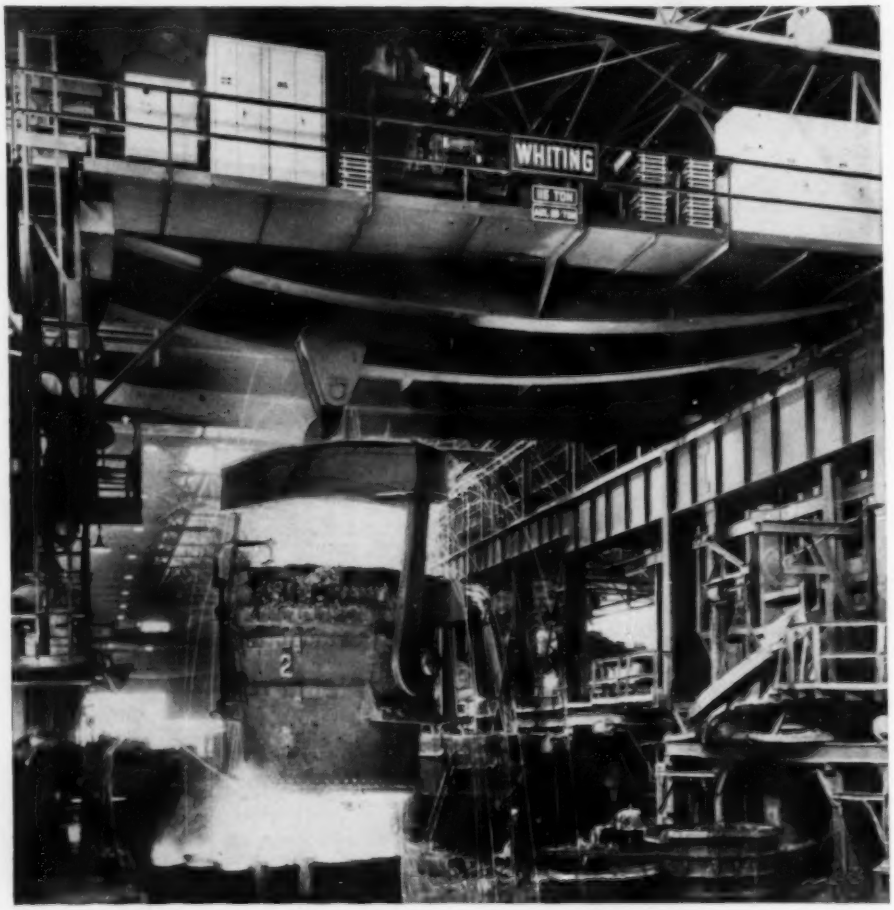
G-E Crane control is tailored to today's steel needs

A complete line of control for d-c crane applications makes it possible for General Electric to tailor systems exactly to steel mill requirements. G.E. has had over 50 years' experience in designing and manufacturing crane controls.

Minimum maintenance is required with General Electric crane control. Each component is tested under severe operating conditions and proved for the job before delivery.

Well integrated systems are assured you when one manufacturer co-ordinates the complete crane drive. General Electric engineers will help you get the most out of your crane installation by working with you or your crane manufacturer from initial design to final installation.

You can save thousands of dollars a year in materials handling costs because of the handling accuracy inherent in G-E controls. Write for Bulletin GEA-5408A (see coupon on right).



Lower maintenance, longer service with G-E Limit Switches

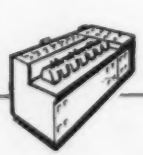
Heavy duty construction of General Electric rotating limit switches enables them to stand up under the rugged shock, vibration and dust conditions of steel mill operation.

Double-break contacts provide long life by providing two contact surfaces. Each contact is independently adjustable for opening or closing. Insulated parts are high-quality non-conductors. There are no shunts or drum-type segments to maintain.

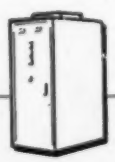
Wide range of gear ratios and types of enclosure give G-E limit switches great versatility. General Electric has a complete line of heavy duty track-type and rotary limit switches. Write for Bulletin GEA-5994 (see coupon on right).

* Trade-mark of General Electric Company.

G-E control for the steel industry meets AISE standards and is designed for rugged operations in steel mills. From simple resistors to complex mill drive control, General Electric Company will supply all your steel mill needs.



SPECIAL STEEL MILL CONTROLS



SYNCHRONOUS MOTOR CONTROL

LIMITAMP CONTROL

News for the steel industry

G-E Master Switches designed for tough steel applications

Available with up to 12 circuits as standard equipment, G-E master switches are specifically designed for rugged applications. Cam-operated and dustproof, they are ideally suited for steel mill drives, crane hoists, and other tough materials handling operations.

Rugged, tight-fitting, cast aluminum covers help protect operating cams and contacts against dirt, dust and damage from external blows. A wide variety of operating mechanisms are available.

All sizes of G-E master switches are actuated by cam assemblies which can be modified easily to change operating sequence. Position feel is obtained by a star-wheel and pawl arrangement which is adjustable to operator's preferences.

It is easy to remove stationary and movable contacts in a minimum of time without disturbing the switch wiring. For more information on G-E master switches call your nearest General Electric Apparatus Sales office.

Simplified Installation—low maintenance with G-E drum switches

Installation and maintenance time on General Electric's full line of drum switches has been substantially reduced by designing all working parts to be completely accessible.

Conduit boxes are provided with knockouts in the bottom, back and sides so many connections can be made.

Easily removed front covers (back covers also on larger units) provide room for wiring and for adjustments.

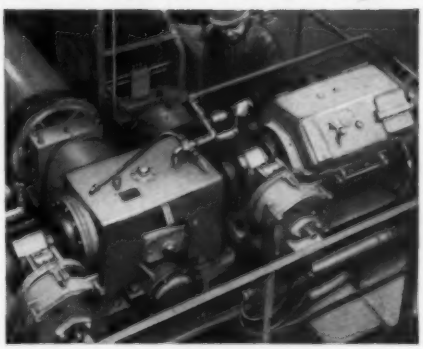
Doubled contact life is possible with G-E drum switches. Reversible finger contacts mean the elements need only be turned over when excessive wear is noted. Only one screw has to be removed to do this. Segments are easily replaceable and they can often be turned end for end to provide even longer life.

Operating mechanisms are interchangeable—standard horizontal handle for rope wheel, vertical handle, or switchboard mechanism. In addition, the mechanisms may be positioned in increments of 90° for maximum flexibility. Write for Bulletin GEA-6307.

New G-E DC Brake provides excellent service at Jones & Laughlin

Jones & Laughlin Steel Corporation, one of four leading steel companies that participated in field testing G.E.'s new d-c brake, specified several more brakes for a slab handling crane on the basis of the excellent performance of the test brake.

Typical initial installations included screwdowns, billet chipper, slab depiler, manipulator crane, and coil unloader. Over 600 subsequent installations have proved the brake's performance under severe operating conditions.



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- ☐ GEA-5994. LIMIT SWITCHES
- ☐ GEA-6307. DRUM SWITCHES
- ☐ GEA-6214. DC BRAKES

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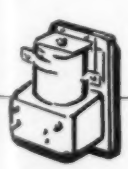
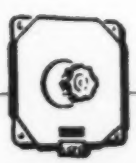
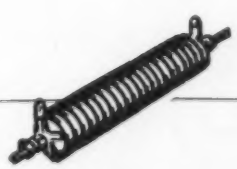


RELAYS

CONTACTORS



RHEOSTATS



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Maybe this year is the year your business will own a P&H Overhead Crane. The time for you to get our experienced engineers on the job is right at the very beginning of your plans. There's no charge, of course, for our advice.

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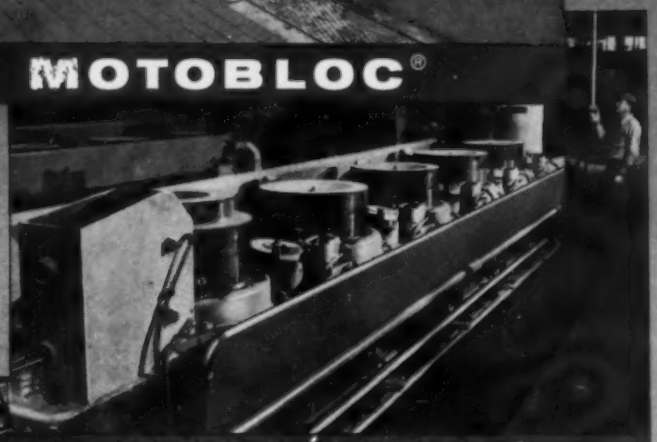

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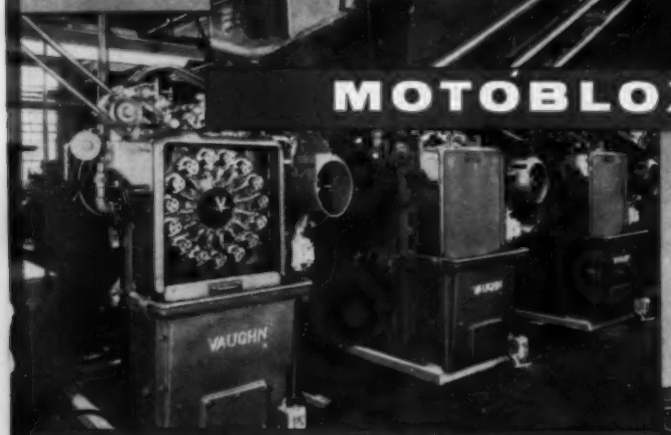

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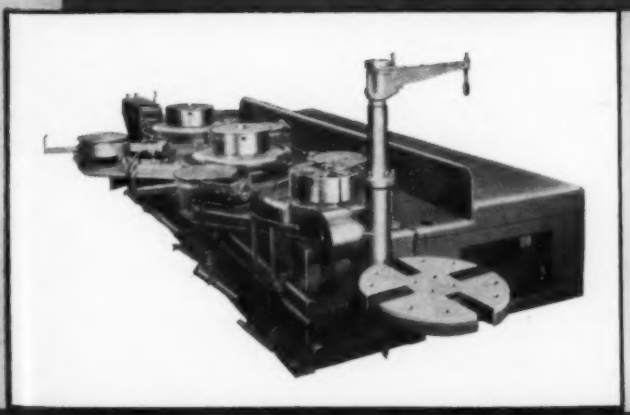

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Universally recognized leaders in AC field excitation equipment.

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Grade SA-45 for most standard DC excitation equipment. Other grades may be required to meet special operating conditions.

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Grade SA-45 **Grade 259** **Grade SA-35**

Standard grades, choice being determined by machine characteristics.

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For unusual service — light loads or severe load swings.

AC SIDE OF ROTARY EQUIPMENT

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Metal-graphite slip-ring formulation, applied according to current density.

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Standard choices, based on service requirement.

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Special for low current density applications.

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MARCH, 1956

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Note: Post cards expire three months after publication date.

(1) Sintered Bearings

A useful bulletin published by The United States Graphite Co., discusses design requirements, metallurgical requirements, and alloy selections of sintered metal bearings for various applications. A table is given that pairs specific bearing needs with the Gramix alloy that best fulfills each need, and adds pertinent comments. Another table lists the Gramix grades and composition, average density, average tensile strength, elongation, and average radial crushing strength of each.

(2) Industrial Trucks

Published by Automatic Transportation Co., is a 16-page illustrated catalog of their whole line of electrically-driven industrial trucks. Trucks that range in size and load capacity from the operator-led transporters to fork and ram trucks capable of lifting loads up to 100,000 lb., are covered in this new catalog. Among the equipment illustrated are platform and pallet trucks, tractors, cranes and special trucks of various kinds. Also included are gas-powered trucks with electric transmissions, which eliminate the need for clutches, gears, overdrive or hydraulic torque converters. Complete specifications for each model are listed as well as the aisle width and turning radius required by each type of truck.

(3) Gearmotors

Available from Reliance Electric and Engineering Co., is a two-color bulletin describing gearmotors. A detailed two-page cutaway view of the gearmotor points out the features that make these gearmotors outstanding. A section illustrates the simplified maintenance through ease of motor and gear replacement with an exploded view of a typical gear assembly. The eight-page bulletin includes a selection section listing types of gearmotors, types of service, output speeds, electrical characteristics, enclosures, and types of mounting. (Bulletin E2408)

(4) Rust Prevention

Rust-Oleum Corp., has published a new 28-page catalog discussing rust prevention. Included are 102 color chips showing the colors available in primers, short oil type coatings, oil field finishes, restful color group finishes, machinery and implement colors, long oil type coatings, heat resistant coatings, chemical resistant coatings, and floor and deck coatings. Important highlights are the two pages devoted to Rust-Oleum penetration through rust to bare metal as measured by radio-active tracer techniques specially formulated to be applied right over new galvanized, aluminum, and terne plate surfaces without etching or excessive weathering. (Form No. 255)

(5) Carbon and Alloy Steels

A booklet that compares carbon and alloy steels for pressure vessels has been published by Lukens Steel Co. The booklet contains a study of this comparison and nine graphs. The first graph plots allowable stress against temperature for the various carbon and alloy steels under discussion. The other graphs are paired according to maximum service temperature in increments of 100 for 650 to 950 F.

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51	AMERICAN BRIDGE DIVISION, UNITED STATES STEEL CORP.		Heroult electric furnaces.
52	BAILEY CO., WILLIAM M.		Kennedy blast furnace stove checkers.
53	BAILEY METER CO.	SPEC. E12-5	Recorders.
54	BRISTOL CO.	BULLETIN P1260	Automatic heating controls.
55	BUSSMANN MFG. CO.	BULLETINS FIS & HCS	Dual-element fuses and hi-cap fuses.
56	CHEMICAL CONSTRUCTION CORP.		Venturi scrubbers.
57	COLUMBUS McKINNON CHAIN CORP.	BULLETIN 100	Sling chains.
58	DODGE MANUFACTURING CORP.	BULLETIN A-620	All-steel pillow blocks.
59	DRAVO CORP.	BULLETIN 225	Trolleys, bridges, towers and other related equipment.
60	EICHLEAY CORP.		Services offered to the industry.
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62	ELECTRIC SERVICE MANUFACTURING CO.		Case histories on aluminum conductor systems.
63	FARVAL CORP., THE	BULLETIN 26-R	Centralized lubrication.
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83	PANGBORN CORP.	BULLETIN 224	Descaling machines.
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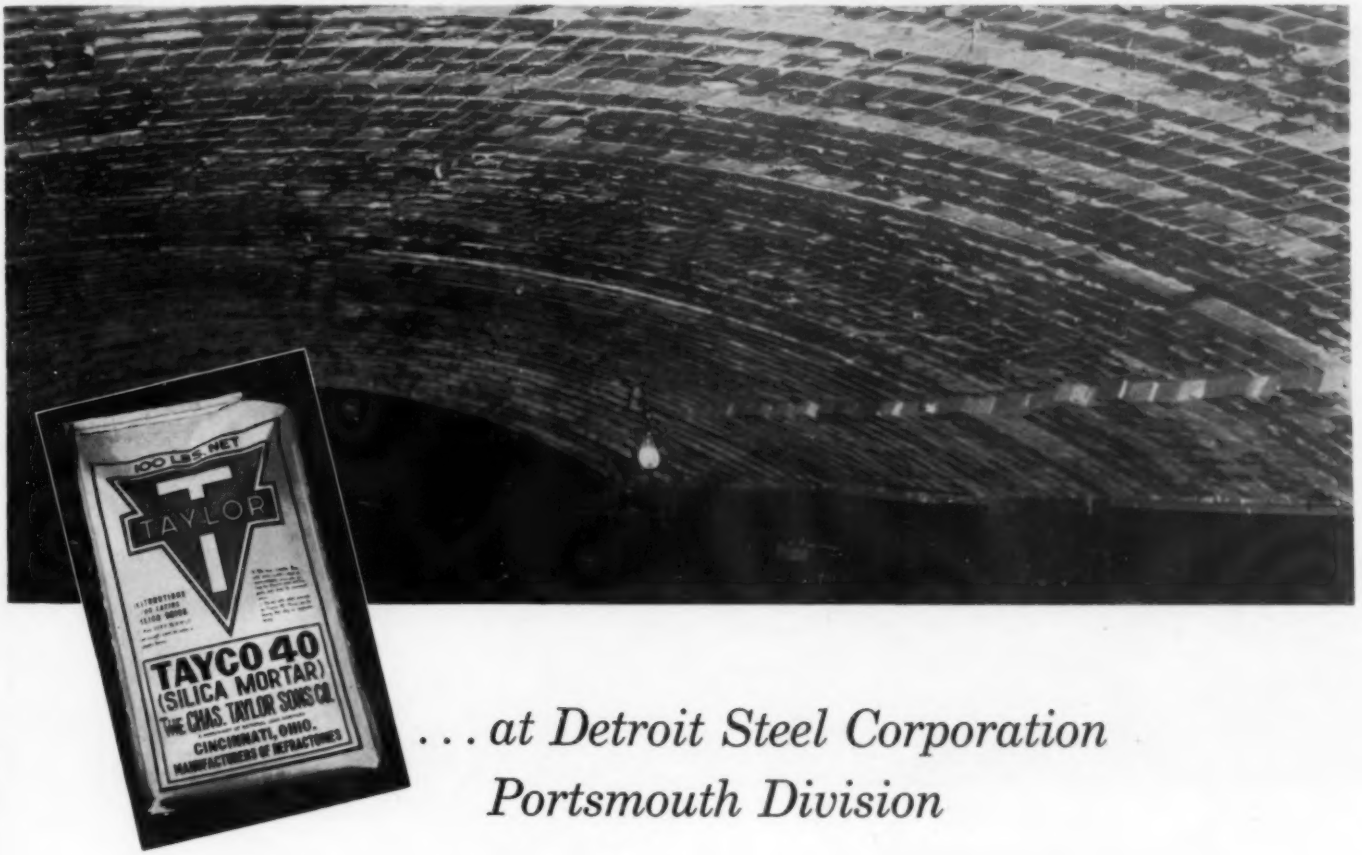
Tayco 40 BONDS THE ROOFS...

Photograph courtesy of Detroit Steel Corporation



. . . at Detroit Steel Corporation Portsmouth Division

The Portsmouth Division, Detroit Steel Corporation—as well as other leading steel mills in the United States—is using Tayco-40 High Temperature Silica Cement to improve the life of silica open hearth furnace roofs.

Tayco-40 is nearly as refractory as the best grades of silica or super-duty silica brick. Because of its superior water-retention properties, Tayco-40 is smooth working—remains plastic longer—making it easy to lay brick with thin, tight joints. These properties are obtained without the addition of plastic fire clays found in most silica cements.

If your open hearth shop has not yet tried Tayco-40, see the Taylor field engineer in your district or write direct for a sample and copy of Bulletin No. 507.

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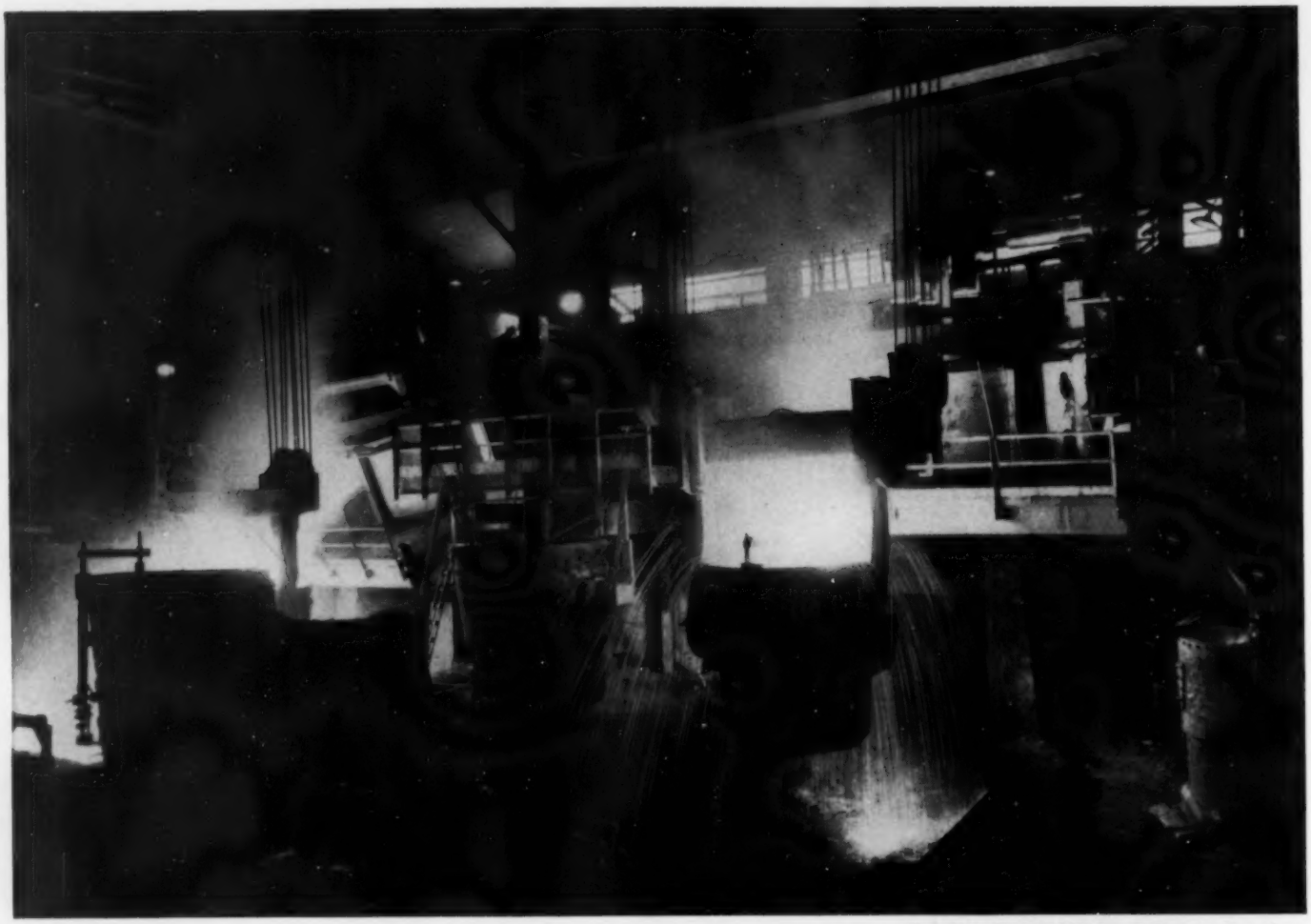
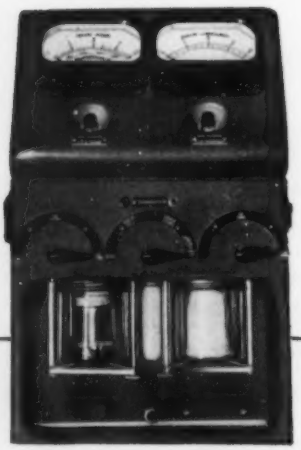


Crucible Steel, Midland, Pennsylvania

"Cities Service Heat Prover helps make special steel, saves fuel"



THE CITIES SERVICE HEAT PROVER . . .

Not an instrument that you buy . . . but a service we supply! . . . FREE!

Crucible Steel Company of America is another leading steel company that has found the Cities Service Heat Prover a valuable aid in its furnace operation.

Here's what Crucible has to say about the Heat Prover at its Midland Works, one of several where it is in constant use.

"The Heat Prover has become our standard tool for the setting up and checking of combustion controls on our many furnaces at Midland. It has also helped immensely in setting up special atmospheres for special grades of steel by providing fast and reliable analyses, and has been particularly instrumental in the improvement of fuel economy. Cities Service has kept the Heat Provers in perfect running order and on many occasions has gone out of its way to help us."

You, like Crucible Steel, can achieve better results in *your* furnace operation with the Cities Service Heat Prover. Supplied and maintained free by Cities Service, it offers easy portability, rapid continuous sampling, simultaneous reading of oxygen and combustibles. For more information, talk with a Cities Service Lubrication Engineer. Or write: Cities Service Oil Company, Sixty Wall Tower, New York 5, N. Y.

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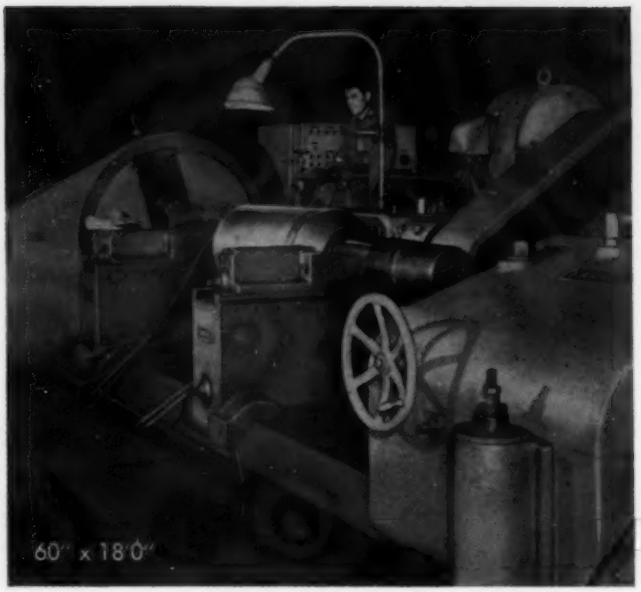
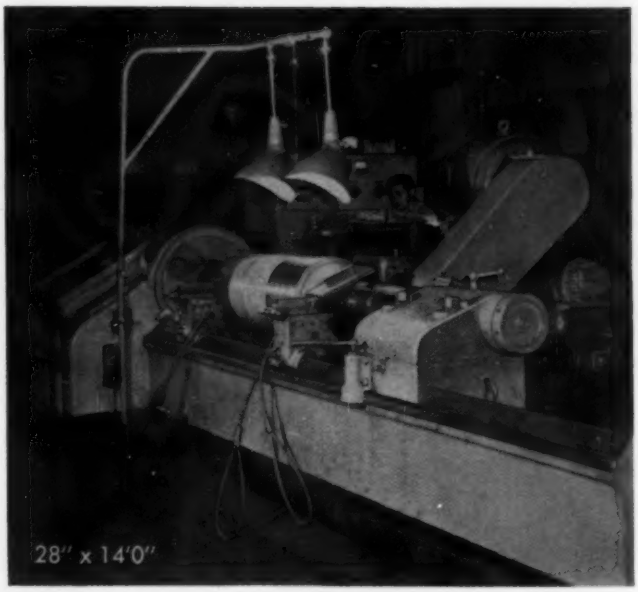
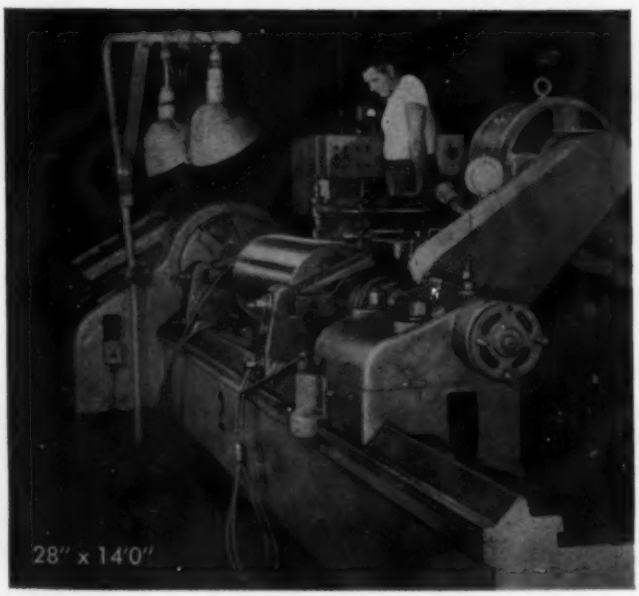
QUALITY PETROLEUM PRODUCTS



They have taken the "GRIND" out of roll grinding at the Aliquippa works of J&L





Drudgery takes a back seat in roll grinding at Jones & Laughlin's Aliquippa Works.

The three Farrel® heavy duty grinders they have are easy to set up, easy to operate, and the required accuracy—whatever it may be—is easy to obtain.

For example: The spindle assembly, including bearings and drive, is designed to give the grinding wheel extremely smooth and accurate performance, when either roughing or finishing. The spindle itself is large in diameter for necessary rigidity under working load.

For example: The automatic crowning device, which grinds a mathematically accurate curve, is simply and quickly set, and requires no manipulation during operation. The same setting produces exactly the same curvature and permits fixed, uniform and easily controlled accuracy of contour in all rolls.

For example: Carriage traverse is reversed electrically, automatically, and dwell can be set for any elapsed time required.

These are only three of the features which take the "grind" out of the operation of Farrel roll grinders. For the full story, send for descriptive bulletin.

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HOW TO PUT NEW LIFT LIFE IN OLD CRANES

Cranes stay in service longer than most other equipment; but after long-time service, production needs usually outstrip the lifting power or speed of the older cranes.

Alliance engineers rejuvenate these old faithfuls to fit current or future needs. For instance, we may be able to increase or decrease the span, change hoist arrangement, install new power units, or relocate a crane to gain more lifting power or speed for your plants. These or other changes will make new cranes out of old.

Check with Alliance about reconverting the old Cranes in your plant.

This 120-ton gantry crane built by Alliance has one of the highest lifts on record– 255 feet. The crane is used for regulating the conduit emergency gate and radial gates on the Hiwassee Dam of TVA.

Whether you need new cranes or want to increase lifting power of old cranes, check with Alliance, world's largest builders of the world's largest cranes.

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Equipment News...

GAS SAMPLING SYSTEM

▲ Designed by Leeds and Northrup Co., for use with their magnetic type oxygen analyzer is a new gas sampling system for the measurement of O_2 content in open-hearth flue gases. This new system solves the difficult problem of obtaining a continuous, dirt-free sample with a minimum of maintenance. Reliable measurement of O_2 content as an index of furnace performance offers the promise of faster heats and thus increased steel production.

The analyzer and its recorder or recorder-controller can be located up to 200 ft from the sampling point, with as little as five seconds lag in the sampling line.

The sampling system comprises: a water-jacketed probe, a stream ejector, a jet condenser, and a centrifugal separator. Each component has a key role in providing a dirt-free sample under continuous, trouble-free operation.

View shows panel board containing oxygen analyzer and (above it) recorder-controller.

The sample probe has an outer jacket through which water continuously circulates to cool the tube against the effects of the high temperature flue gas. In the center of the probe a tube carries filtered water to a nozzle assembly which washes the probe opening with jets of water. These jets keep the end free of slag. Small radial sprays from the nozzle flush the sample passage to prevent accumulation of dirt.

The mixture of flue gas sample and wash water are drawn from the probe by suction of a steam ejector. Steam thoroughly mixes with the gas and dirt, and the mixture passes to a jet condenser. In the condenser, a water jet causes the steam to condense, thereby wetting the dirt particles thoroughly so that they can be removed in the centrifugal separator. The condensation process also removes corrosive gases.

Water and wetted dust are spun to the outer periphery of the separator and then flow to the bottom. The clean gas sample leaves the top of the separator, under positive pressure which delivers it to the analyzer at high velocity and eliminates chances of sample contamination due to leaks in the piping. And this thoroughly scrubbed, acid-free sample assures minimum system maintenance by eliminating plugging or corrosion of the sample line.

The two gas sample lines from the sampling systems are connected to a reversing valve at the analyzer-recorder panel. This valve is automatically operated during furnace reversals to connect the exhaust down-take side to the analyzer. At the same time, the sample from the opposite furnace end is vented to atmosphere. Thus, except for the brief period after reversal (before conditions have stabilized to the point of producing a significant O_2 measurement) the system provides a continuous oxygen analysis of the open-hearth flue gas, regardless of the frequency of reversals.

The gas sample from the automatic reversing valve enters the analyzer through a separator where any condensate formed in the sampling line is removed. It then passes through a filter and rotameter assembly which maintains a constant rate of flow to the analyzer cells.

COLD REDUCTION MILL OPERATING IN JAPAN

This new four-high reversing cold reduction mill especially engineered to roll both sheet steel and tinplate now operating at Yodogawa Steel Works, Ltd., Osaka, Japan, was designed and built by E. W. Bliss Co. The mill has an unusual dual roll coolant system making it easy to shift from the water soluble oil solution needed when rolling sheet gages, to palm oil or similar tinplate rolling coolant. Roll arrangement is 16 in. and 53 in. by 54 in., enabling the mill to process strip up to 48 in. in width. Maximum mill speed is 2012 fpm.

STRAIGHTENER

▲ A new high-speed straightening and polishing machine designed to polish as it straightens cold drawn bars of from ¾ to 4½ in. in diameter has been designed by Sutton Engineering Co.

With a rated production speed of 300 fpm, this straightener can be installed directly in a fast mill line. Entry and delivery tables can be added for automatic handling of the drawn and sheared bars.

The pass line is horizontal with two large rolls opposed by three

DELTA-STAR Products for Mills and Industrial Plants

Reinforced Bus Structures • Crane Rail Supports
Interrupter Switches • Load Break Switches
UNI-TRAY Cableways • Terminators (Potheads)
Plugs and Receptacles • Power Connectors
Spool Insulator Cable Supports • Water Cooled
Conductors and Fittings • Outdoor Substations

Meet your special power switching needs with DELTA-STAR Disconnects

What's *your* problem? If it involves electrical power switching, here's a demonstration how Delta-Star helps you. It shows how you meet exact specifications—gain long, efficient equipment service.

The special indoor disconnect switches shown above were designed specifically to solve a problem of by-passing and disconnecting heavy power loads. They are basically Delta-Star's unit-type single pole 6000 ampere, 600-volt J-14P Disconnects mounted on a common base. The special switch design also solved a limited space problem.

Delta-Star high capacity disconnect switches are built for easy, safe operation and heavy duty service. They feature an exclusive ball bearing pressure applicator, floating tongue-type, double-blade construction, with individually sprung, high pressure silvered button contacts. All current carrying parts are hard drawn copper. Straight-line current path reduces current interchange surfaces to a minimum.

Make use of Delta-Star's excellent reputation for precise engineering, quality products and special service. You get the kind of help you want when you need it.

For the best in high voltage electrical equipment, specify DELTA-STAR

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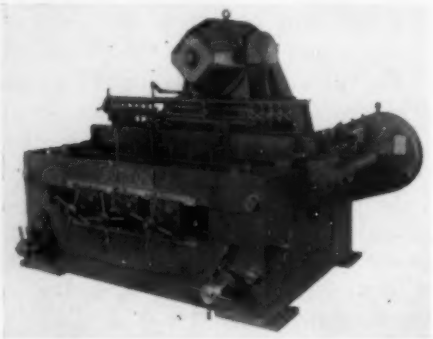
smaller rolls. Four of the five rolls are driven to provide the correct amount of burnishing action required to give the bars a bright, smooth finish as they are being straightened. Concentricity is controlled by the machine and size tolerance can be controlled by raising or lowering the diameter of the bar, depending on the analysis of the grade being straightened.

Power is provided by a 60/70 hp, 400/1600 rpm, 230 volt, adjustable-speed d-c motor. All controls are



readily accessible and change-over from one size to another can be made quickly. The machine is ruggedly built for heavy-duty service with anti-friction bearings used throughout. Floor space is conserved by a top-mounted motor.

A wide variety of grades may be straightened such as high or low carbons, Bessemer grades and different alloys, all at high production speeds with equally good end-to-end straightness and quality of end product.

REINFORCED BUSHINGS

▲ Announced by Adalet Manufacturing Co., are new glass insulating conduit bushings available for all conduit sizes. These glass reinforced bushings have greater strength; can withstand higher temperatures; show a dielectric of 390 volts per mil; are self extinguishing after being exposed to flame; and show practically no water absorption.

They are available at no extra cost over ordinary phenolic bushings.

SIDE-BREAK SWITCHES

▲ Announced by Delta-Star Electric Division, H. K. Porter Co., Inc., is a new line of braidless side-break switches which features new high pressure contacts throughout and low friction swivel terminals.

Here's how to solve your bearing replacement problems!

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BEARING SURVEY FOR YOUR PLANT

You'll Gain These *Seven* Advantages

- **FACILITATES** continuous production
- **REDUCES** machine down time
- **SAVES** labor man hours
- **PREVENTS** expensive delays
- **PROMOTES** low cost maintenance
- **CUTS** inventory to minimum
- **KEEPS** replacements in stock

Regardless of the kind or number of machines in your plant, you can practically eliminate your bearing replacement problems—by means of the unique Bearing Survey developed by this company. It will provide you with an automatic bearing replacement program. It will enable you to keep production high, maintenance low, and your own bearing stock at a minimum. Large and small companies using it save time, labor, money. You can expect the same results. For a Bearing Survey for your plant—dial the number below. There is no cost, no obligation.

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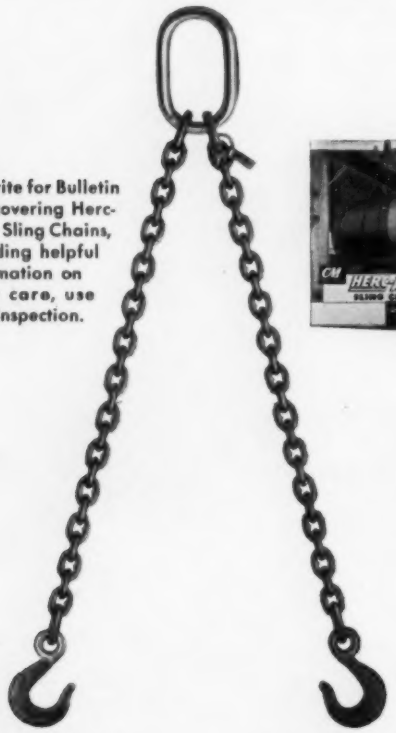
● Herc-Alloy is the only exact-size alloy chain on the market. This uniformity gives you a lighter and easier-to-handle chain without any sacrifice in working load limit.

● Herc-Alloy, the original alloy steel chain, is available in running lengths as well as in all types and sizes of slings made to customer specifications.

● Write for Bulletin 100 covering Herc-Alloy Sling Chains, including helpful information on their care, use and inspection.



● CM also produces a complete line of chain attachments and welded chain of all types including stainless steel and bronze.

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Braids are completely eliminated by means of newly developed high pressure "on center" contacts at all rotating contact points. These new switches include center-break, single-break, and double side-break switches in a wide range of voltage and ampere ratings to 1200 amp as well as both standard and heavy fault ratings.

STRADDLE CARRIER

▲ Introduced by the Ross Carrier Division of Clark Equipment Co., is a 30,000 lb capacity straddle carrier. This machine has a new five speed syncromesh transmission, 15 per cent more hp at the wheels, fully hydraulic control of load hooks and four-wheel radi-arc steering.

Replacing Clark's previous model, this machine incorporates features designed to meet the needs of both rugged steel mill service and high speed lumber operation.

All-welded steel construction pro-

vides maximum strength with minimum weight. All power train components, including clutch, differential, transmission and chain drive, are designed for heavy-duty, high-stress operation. Power steering is provided as optional equipment at extra cost. Tubular cross members in the frame are used as fuel and hydraulic tanks, thus increasing operator's visibility.

SWITCHGEAR DESIGN

▲ I-T-E Circuit Breaker Co., has announced a low-voltage drawout switchgear that accommodates the 4000 amp type KE circuit breaker in a 36 in. wide compartment, providing small space requirements for breakers with interrupting ratings of 150,000 amp at 240 volts and 100,000 amp at 480-600 volts.

This switchgear mounting allows the breaker to be in its test position

with the compartment door closed, giving increased safety and added dust protection. New, high-efficiency arc-interrupters contribute to its compact design.

SPEED REDUCERS

▲ Shaft-mounted speed reducers with capacities from one to 60 hp and output speeds from 12 to 365 rpm have been announced by Dodge Manufacturing Corp.

The new size No. 8 has a capacity of 60 hp at 100 rpm, AGMA rating, and can be mounted on shafts up to 5 in. diameter. The new No. 11 has a capacity of 1.3 hp at 100 rpm.

No foundation, no flexible couplings, no sliding base is required for any of these reducers, and there are no lining up difficulties. The reducers are mounted d rectly on the shaft, and the torque-arm is fastened to any fixed object, anchoring the reducer. The unit is driven through a V-belt drive. Taper-lock sheaves permit any speed ratio desired.

The overload release which loosens the belts, cuts off power, and gives a warning in case of excessive load, is available for use with any torque-arm reducer. A built-in backstop may also be provided when conditions require a device to prevent the reversal of the direction of rotation.

CARBON ANALYZER

This new vacuum-fusion device for measuring to within 5/10,000ths of a per cent the carbon content of steel is being operated at U. S. Steel's new research center in Monroeville, Pa. The apparatus measures the carbon dioxide generated by burning a steel sample in pure oxygen.

RAM TRUCK

Automatic Transportation Co.'s new split ram carries two steel coils in one trip, increases utility of heavy ram trucks in rolling mills.

D-C MAGNETIC BRAKE

▲ Available from the Westinghouse Electric Corp., is a d-c magnetic brake that eliminates need for adjustment throughout its service life. This self-adjusting feature decreases maintenance and down time and provides longer lining and wheel life.

Regardless of lining wear or wheel expansion the brake shoe remains in correct adjustment and proper alinement with the wheel; once the correct torque setting is made for a given application, it need never be changed.

By not permitting shoe tips to drag, the self-alineing feature provides for even lining wear, and in some applications increases lining life up to 50 per cent. Wheel wear and scoring are also minimized.

The brake is available in sizes to

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• Hammerlok is made of alloy steel... is stronger than Herc-Alloy chain... is thoroughly field tested.

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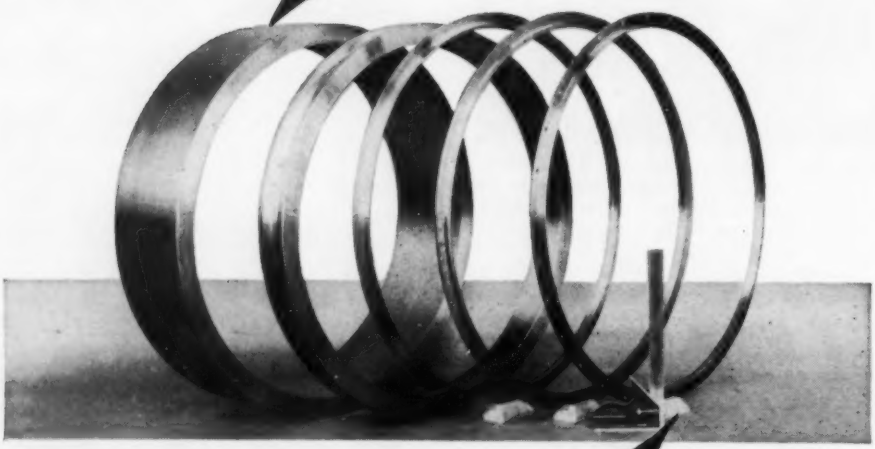


CUT and FINISHED by THE CUSTOMER

High Alloy rings for jet engines . . . we did the casting and rough finishing and the customer did the cutting and final finishing.

Centrifugally cast metal gives an exceptionally fine, dense, uniform grain structure. The strength of the metal approaches that imparted to a bar or ingot when it is hot forged. It produces an ideal metal for the tough service required of jet engine parts.

Incidentally, as evidence of our knowledge of and experience with tough alloy castings — static as well as centrifugal — the records show very few rejections by this engine manufacturer who subjected each of the many rings we furnished to his own very rigid tests.

May we suggest that you let Duraloy work on your high alloy castings — chrome iron, chrome nickel or nickel chrome? We have the experience and facilities for turning out high quality castings.

10-DJ-4

THE DURALOY COMPANY

Office and Plant Scottdale, Pa. · Eastern Office 12 East 41st Street, New York 17, N.Y.

Detroit Office 23900 Woodward Avenue · Pleasant Ridge, Mich.

Atlanta J. M. TULL Metal & Supply Co. Chicago F. O. NELSON 332 S. Michigan Avenue

METAL GOODS CORP. Dallas · Denver · Houston · Kansas City · New Orleans · St. Louis · Tulsa

fit all d-c motors. Application to a-c motors is possible through the addition of rectifiers.

STEAM CLEANER

▲ Announced by Homestead Valve Manufacturing Co., is a new hypressure jenny steam cleaner.

This new steam cleaner has a slow-speed positive displacement pump with disc check valves which guar-

antees extra long service, a "no-stoop" control panel, remote control to stop and start machine at cleaning gun even though operator may be 100 ft or more from this unit, and a minimum of 2 gpm at any pressure.

The new hypressure steam cleaner is available in 11 different portable or stationary models with a choice of electric motor or gasoline engine drive.

PROCESS TIME RECORDER

▲ A new application for the General Electric Co.'s potentiometric round-chart recorder permits direct reading and recording of "time in process" for continuous ovens, furnaces, kilns and lehrs.

Process engineers at the company's Instrument Department said the round-chart recorder is used with a tachometer-generator connected to a conveyor belt drive. The tachometer generator furnishes a signal proportional to the conveyor speed. The reciprocal of speed—time—is the quantity to be recorded, therefore the tachometer-generator's speed signal must be converted. This is accomplished by a slide wire coupled to the self-balancing potentiometric recorder, which records the process time directly in minutes.

The line of round-chart recorders features continuous standardization, and use of a magnetic standard as ref-

(*Please turn to page 205*)

TIPS FROM A ROLL MAKER'S NOTEBOOK

MACKINTOSH-HEMPHILL DIVISION, E. W. BLISS COMPANY, Pittsburgh 3, Pennsylvania

Cast mill rolls • Johnston cinder pots • rotary tube straighteners • end-thrust bearings • heavy-duty lathes • steel and special alloy castings

Choosing rolls for slabbing and blooming mills

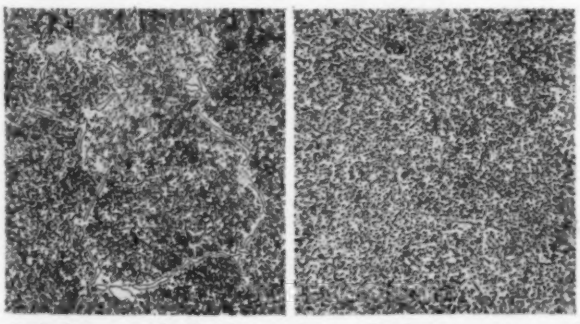
Cast steel rolls for blooming and slabbing mills must combine good resistance to fire cracking with the strength necessary to stand the severe stresses developed by these mills.

Other considerations that affect the choice of rolls include severity of the service and the method of roll cooling. Variations like these can mean good service from inexpensive rolls in one mill while in another the only practical solution lies in costlier, higher alloy rolls.

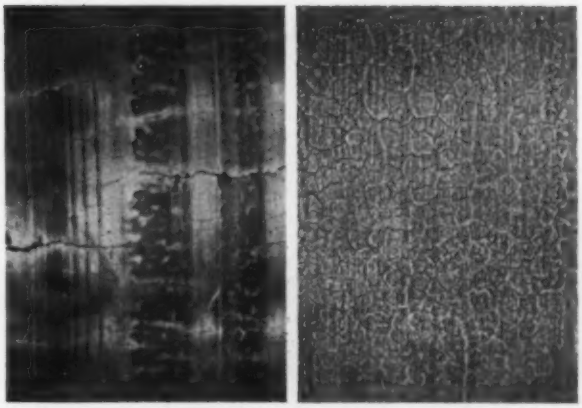
Two heat treatments – Heat treatment is used primarily to improve roll strength. However, heat treatment also affects resistance to fire cracking – metallurgists believe that there is a relationship between fire cracking and the elimination of the carbide network from the crystalline structure of cast steel.

Mack-Hemp has developed two heat treatments for blooming and slabbing rolls. The first is an air quench and draw, and develops maximum strength. It produces rolls with excellent resistance to the very severe localized concentration of stress that occurs each time the steel goes through a pass.

The second heat treatment, a double anneal, produces a spheroidized carbide structure with good strength and excellent resistance to fire cracking.



Carbide network (left) stands out clearly in specimen of roll with ordinary treament. Picral etch, 500 magnifications. Network in Midland Superalloy (right) has been almost completely destroyed by special Mack-Hemp heat treatment. Picral etch, 500 magnifications.



Severe fire cracking ended the service life of the slabbing roll whose surface is shown at the left. Surface of Midland Superalloy roll at right shows excellent fire cracking pattern (roll had reached worn-out diameter after more than 600,000 tons).

Three types of rolls – Both of these heat treatments are modifications of older practices, designed to decrease the amount of grain boundary carbide in the finished roll, thus improving fire cracking resistance. Either treatment can be supplied in the three grades of Mack-Hemp cast steel rolls recommended for slabbing and blooming mills:

Midland Superalloy, a nickel-chrome-moly roll especially developed for applications where fire cracking is a severe problem. There are cases on record where sets of Midland Superalloy rolls have rolled 700,000 tons and more before reaching worn-out diameters.

Technalloy, a chrome-moly roll that has thoroughly proved itself under standard operating conditions.

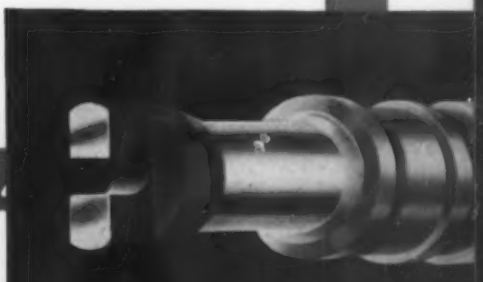
Technisteel, a carbon steel roll which gives good service at low initial cost under mild-to-average operating conditions.

Squeezing maximum tonnages from your mills... at minimum roll cost...is far easier when you enlist Mack-Hemp's aid. For help with your particular rolling problem, write us today.

MACKINTOSH-HEMPHILL

You get more tonnage from the rolls with the Striped Red Wabblers

Division of E. W. BLISS COMPANY
PRESSES, ROLLING MILLS, SPECIAL MACHINERY



big industry, small world

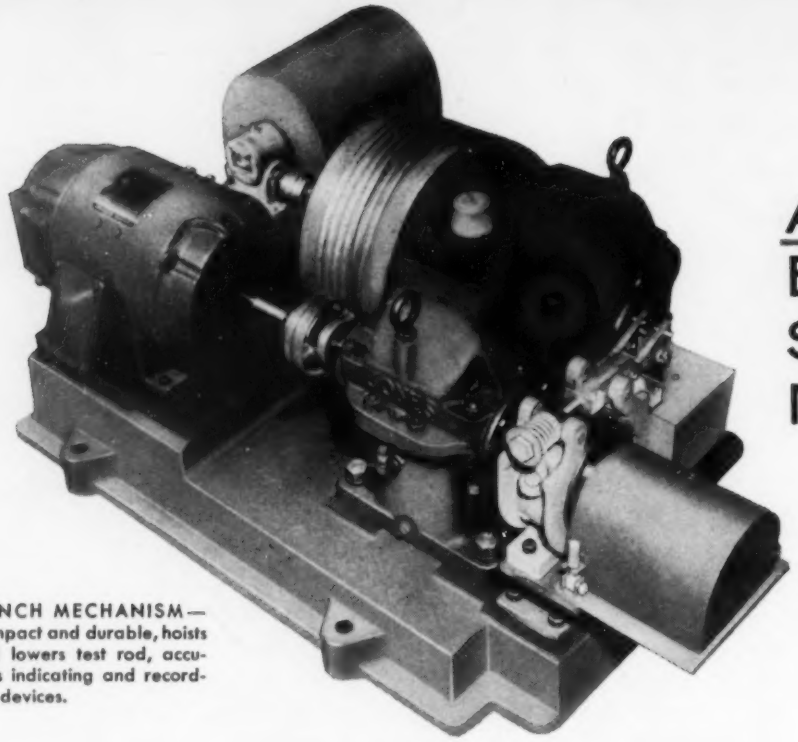
annealing covers
billet reheating furnaces, continuous
carbon restoration and annealing furnaces, continuous
controlled atmosphere generators
high-speed stress relieving furnaces
one-way fired soaking pits
pit-type annealing furnaces
slab and billet heaters, continuous
strip annealing furnaces, continuous
strip galvanizing lines, continuous
wire patenting furnaces, continuous

Wherever this steel goes – from first soak to final shipping dock – it will find that the big steel industry is a small world as far as 'Surface' equipment is concerned. Somewhere along the line, whatever its destined shape, the steel will be made more workable and more useful in 'Surface' furnaces.

Why is it so easy to bump into 'Surface' in steel mills? One reason is that 'Surface' has literally grown up with the steel industry. A better reason is the confidence that steelmakers have in the performance of furnaces and generators manufactured by Surface Combustion Corp., Toledo 1, Ohio.

Surface
STEEL MILL FURNACES

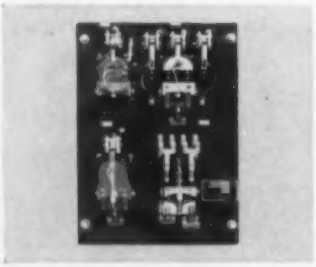
Foreign associate companies:
British Furnaces, Ltd., Chesterfield; Stein & Atkinson, Ltd., London
Stein & Roubaix, Paris, Leige, and Genoa; Chugai Ro Kogyo Kaisha, Ltd., Osaka
Benno Schilde Maschinenbau, A.G., Bad Hersfeld (Hessen, Germany)



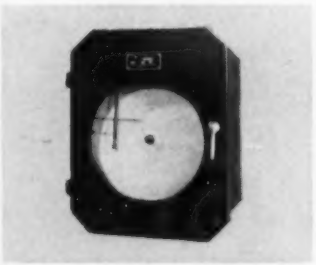
WINCH MECHANISM—Compact and durable, hoists and lowers test rod, accuates indicating and recording devices.

Automatic Blast Furnace Stock Level, Measurement

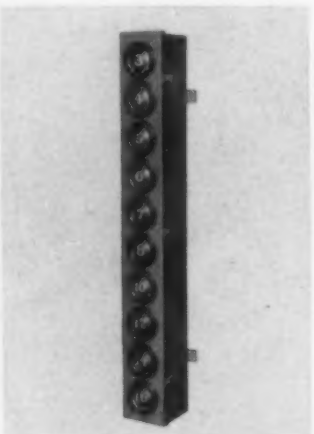
Freyn-Design STOCKLINE RECORDER



CONTROL PANEL—Motor and control resistors are installed in a wall mounted swing-out panel for easy access.



RECORDING METER—Selsyn operating recording meter records actual stock level on chart.



LAMP TARGET INDICATOR—Shows stock level at all times. Unusual arrangement permits mounting in both stock and cast house.

STOCK MOVEMENT VISUALIZER—Magnifies and indicates frequency of burden movement.

Proved in Over 450 Installations

The dependability—and the accuracy—of the Freyn-Design Stockline Recorder has been proved in more than 450 installations. These important reasons tell why blast furnace operators chose Freyn: First, an accurate chart record assures the maintenance of the desired burden level. Second, continuous or intermittent indication of stock level is given. Third, stock movement visualizer shows relative freeness or sluggishness of burden movement—warns of an approaching period of burden stoppage. Fourth, installation of more than one assembly provides a means of measurement on opposite sides of the furnace.

Write for drawings and descriptive information, or consult our engineers.

KOPPERS COMPANY, INC.
KOPPERS
Freyn Department
Engineering & Construction Division
KOPPERS BUILDING • PITTSBURGH 19 Associated with Ashmore, Benson Pease & Co. Ltd., Stockton-on-Tees, ENGLAND De Lattre & Frouard, Paris, FRANCE

(*Continued from page 200*)

erence which eliminates the need for a dry cell or battery as a power source.

ARCWELDING

▲ Three new arcwelding machines—a d-c rectifier, an a-c/d-c rectifier for metallic arcwelding and an a-c/d-c "Heliwelder" for inert-gas and metallic arcwelding—are now available from Air Reduction Sales Co.

The d-c "Bumblebee" arcwelder has improved selenium rectifiers designed especially for welding service to convert alternating current to direct current. It features a single range of current adjustment. New low design permits stacking for parallel operations; weather-proof construction for outdoor operation; patented transformer design produces instantaneous voltage recovery and control resulting in an easy-to-handle arc; and forced draft ventilation assures low operating temperature. The fan is powered by a heavy duty permanently lubricated ball bearing motor. Available in 200, 300 and 400 ampere models.

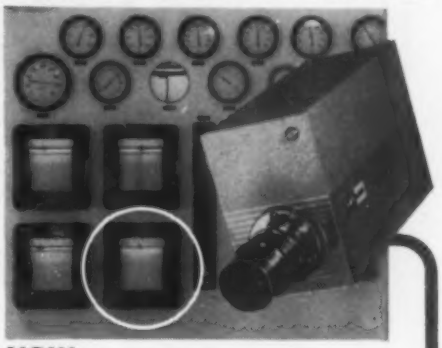
The a-c/d-c "Bumblebee" is designed specifically for metallic arcwelding and will supply either a-c or d-c current by the flick of a switch. Patented control circuit eliminates need for any mechanical type control and selenium rectifiers are specifically designed for welding duty. Both a-c and d-c welding ranges are wide and a rheostat gives micrometer current control within each range of the 3-position switch. This machine is also equipped with a heavy duty, ball bearing fan, factory lubricated for life. Available in 200, 300 and 400 ampere models, with or without power factor correction.

Available in 200 and 300 ampere models, new a-c/d-c "Heliwelders" are designed for use with the various inert-gas arcwelding processes in addition to metallic arcwelding. These machines consist of a single-phase transformer, selenium rectifier and stabilizing reactor, permitting the operator to select either a-c or d-c welding current. High frequency, with a rheostat control, is built-in and balancing resistor in series with transformer secondary provides correct current for inert-gas welding.

ANNOUNCING!
ADALET'S Pegi
(PolyEster Glass Insulating)
PRECISION MOLDED BUSHING
No other molded bushing can even approach the physical properties of Adalet PEGI Bushings.
STRENGTH 10,000 psi tensile
15,000 psi flexural
20,000 psi compression
HEAT RESISTANCE 350° F continuous
400° F intermittent
FLAME RESISTANCE self extinguishing
DIELECTRIC 390 volts per mil
WATER ABSORPTION 1/10 of 1% to 1/5 of 1%
A FORWARD STEP by ADALET
Write for your FREE Pegi sample tagged as shown

THE Adalet MANUFACTURING COMPANY
14300 LORAIN AVENUE • CLEVELAND 11, OHIO

KAY LAB
CLOSED CIRCUIT TV PIONEERS



NOW . . .

YOU CAN USE INDUSTRIAL TV

• EXTEND YOUR VISION •

KAY LAB'S small camera flashes images from remote points and dangerous operations to a central location . . .

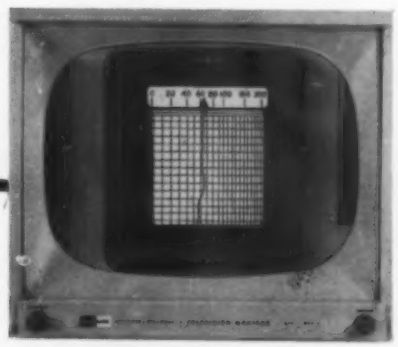
VIEW: Production schedules, charts, blueprints, gauges, meters, flames, smokestacks . . .

OBSERVE: Gates, loading docks, storerooms, manufacturing operations . . .

USE: For plant tours and training, time and motion studies.

TRULY A "TELEVISION INTERCOM"

KAY LAB TV IS UNEQUALLED for laboratory performance combined with rugged durability, simplicity, economy . . . our nationwide staff of field engineers has experience in hundreds of installations . . .



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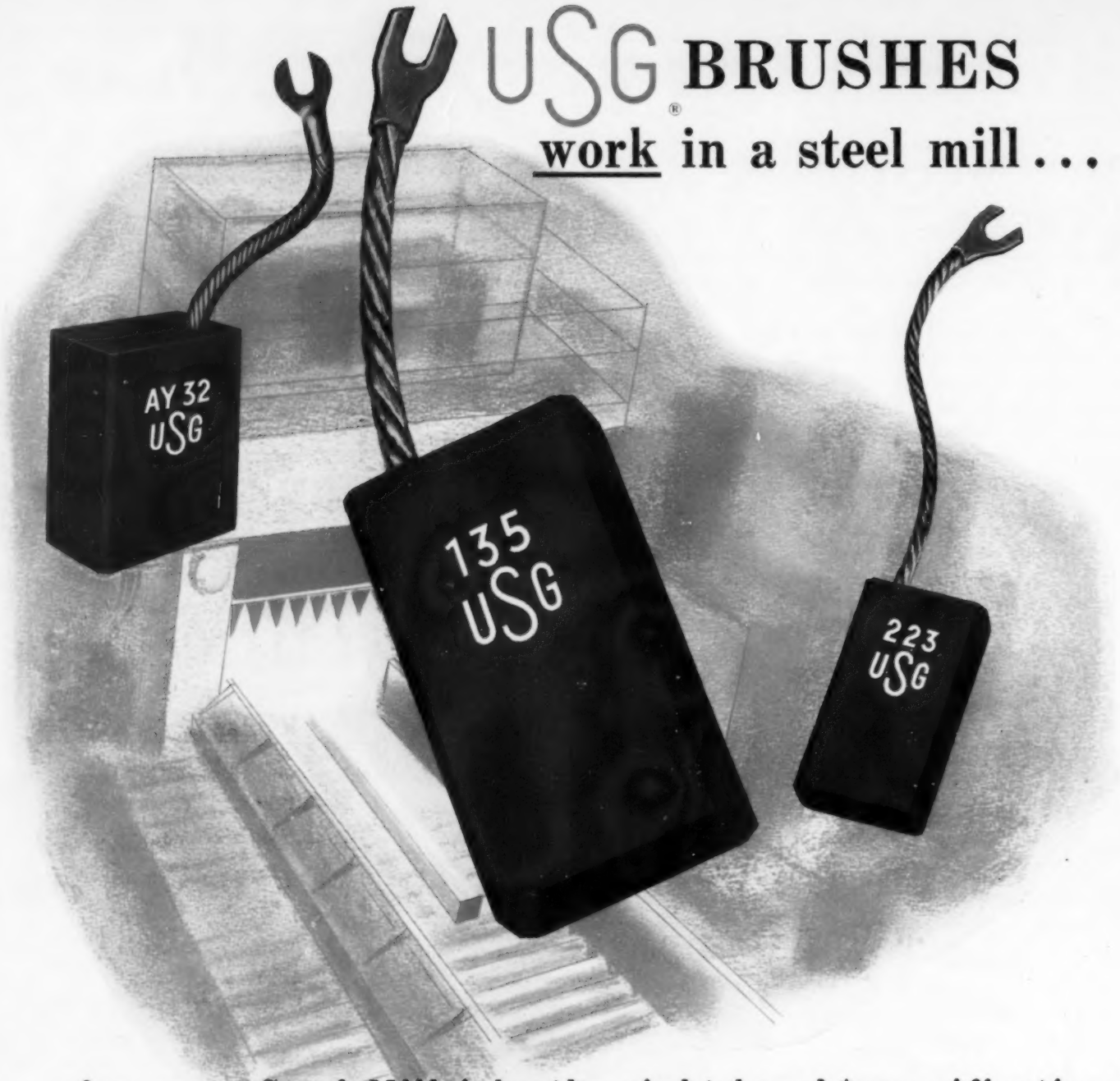
KAY LAB
5725 KEARNEY VILLA ROAD
SAN DIEGO 12, CALIFORNIA

USG® BRUSHES
work in a steel mill...



for every Steel Mill job—the right brush* specification

THE JOB	THE BRUSH
Mill Motors	USG Grade 135
DC Crane Motors	USG Grade 223
Diesel Main Generators	USG Grade AY 32 or 2306
Diesel Switcher Traction Motors	USG Grade 2207
Welding Generators and Exciters	USG Grade AH 897
Tin Line Collector Rolls	USG Grade 1658
Tin Line Generators	Grade on request
Cleaning Line Generators	Grade on request
DC Generators (DC Power Supply)	USG Grade 232
AC Crane Motor Slip Rings	USG Grade 550

*All USG brushes can be obtained with STATITE®, the permanent shunt connection, needing no hammerclips; cannot be jarred loose or pulled out.

Write for your copy of the complete USG Brush Catalog.

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THE UNITED STATES GRAPHITE COMPANY
DIVISION OF THE WICKES CORPORATION • SAGINAW, MICHIGAN

Hyde Park

RED CIRCLE Rolls ALLOY-CHILLED

Rolling Mill Equipment

For more than 50 years Hyde Park Steel Mill equipment has been helping American industry lead the world—equipment such as—

Bar Mills
Merchant Mills
Sheet and Strip Mills
Pinion Stands
Roller Tables
Reduction Drives
Stretcher Levellers
Guillotine Shears
Sheet Mill Shears
Roll Lathes
Special Machinery
Machine Work

For finer finish, long life and greater tonnage, specify Red Circle Rolls.

Hyde Park
FOUNDRY & MACHINE CO.
Hyde Park, Westmoreland Co., Pa.
ROLLS
ROLLING MILL MACHINERY
GREY IRON CASTINGS

GAS INDICATORS

▲ Mine Safety Appliances Co. has just introduced a new line of portable instruments designed to meet industrial needs for detecting and measuring flammable gases and vapors.

Four models, each intended for specific functions, are included in the line. All models are the same size and use standard detector and compensator filament units which are obtainable from MSA warehouse stocks throughout the country. A spare set of the easily replaceable filaments is mounted within each instrument.

Model 20 Combustible Gas Indicator is designed for multiple calibrations. A selector switch on the instrument panel has five different settings for different gases or vapors. No calibration curves are necessary to interpret results of tests.

Model 21 is identical to Model 20 except that it has a dual scale, controlled by a selector switch. One scale provides readings from 0 to 100 per cent of the lower explosive limit. The other provides readings in the range from 0 to 25 per cent of the lower explosive limit.

Model 30 Indicator can differentiate between natural gas and petroleum vapors. Normally, it operates with the detector filament hot enough to burn natural gas and other combustibles in the air sample. A selector switch, however, adjusts the filament temperature to indicate presence of combustibles like petroleum vapors with low ignition temperatures.

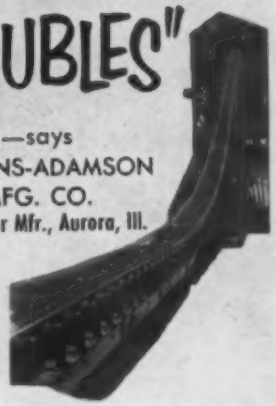
Model 40 is designed specifically for industrial hygiene work and has a dual scale meter, one of which is graduated for 0 to 100 per cent of the lower explosive limit and the other for 0 to 10 per cent. This model is furnished with a special five-ft long sampling line that stabilizes humidity during tests requiring high sensitivity. Variations in humidity could affect critical readings. This style of indicator is normally provided with a calibration curve for interpreting the concentration of a variety of combustibles.

(*Please turn to page 228*)

THE COST OF AN AD THIS SIZE IS $8.00 PER INSERTION

"NO MORE LUBRICATION TROUBLES"

—says
STEPHENS-ADAMSON MFG. CO.
Conveyor Mfr., Aurora, Ill.



"LUBRIPLATE Lubricants satisfy the 'one-shot' requirements of our conveyor idlers. LUBRIPLATE effectively lubricates each bearing in turn and flows through the hollow shaft to the next bearing. We do not know of a single case of bearing trouble through faulty lubrication where LUBRIPLATE has been used."

REGARDLESS OF THE SIZE AND TYPE OF YOUR MACHINERY, LUBRIPLATE LUBRICANTS WILL IMPROVE ITS OPERATION AND REDUCE MAINTENANCE

LUBRIPLATE LUBRICATION

MAKES CARS AND TRUCKS RUN BETTER AND LAST LONGER

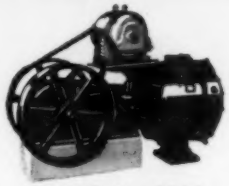
LUBRIPLATE H.D.S. MOTOR OIL . . . THE OIL THAT NEEDS NO ADDITIVES

For nearest LUBRIPLATE distributor see Classified Telephone Directory. Send for free "LUBRIPLATE DATA BOOK" . . . a valuable treatise on lubrication. Write LUBRIPLATE DIVISION, Fiske Brothers Refining Co., Newark 5, N. J. or Toledo 5, Ohio.

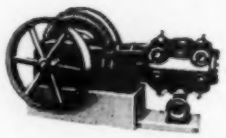
Heavy-duty
ES compressors

provide maximum efficiency in a
WIDE RANGE OF APPLICATIONS

. . . with unusual flexibility of drive and cylinder arrangements



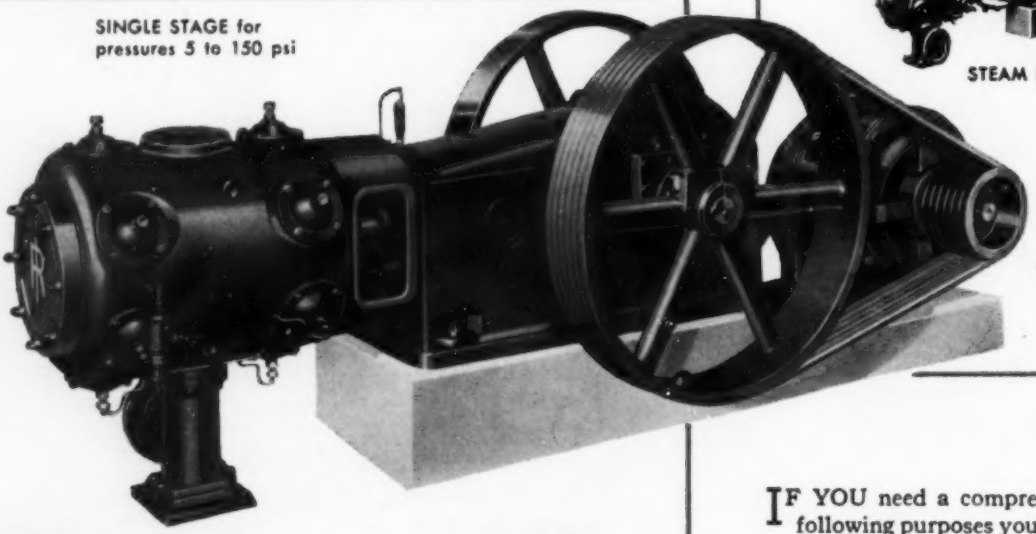
OVERHEAD MOTOR



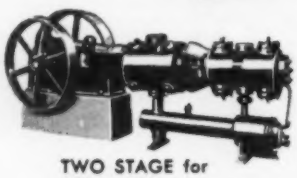
DIRECT-CONNECTED SYNCHRONOUS MOTOR

STEAM DRIVE

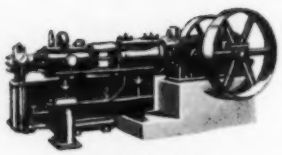
SINGLE STAGE for pressures 5 to 150 psi



V-BELT DRIVE

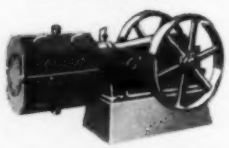


TWO STAGE for 150 to 500 psi

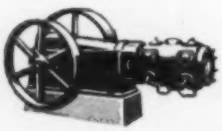


THREE STAGE for 500 to 2500 psi

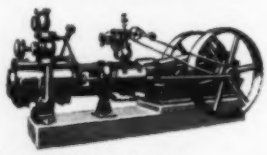
DRY VACUUM PUMPS . . . single or two stage



STEAM-PRESSURE BOOSTERS



NON-LUBRICATED CYLINDERS for oil-free air or gas



REFRIGERATION UNITS for ammonia or other refrigerants

IF YOU need a compressor for any of the following purposes you should consider the Type "ES" compressor . . . a standardized, yet extremely flexible compressor built by Ingersoll-Rand, the pioneer compressor builder.

- To compress air or gas to any pressures between 5 and 2500 psi, or for pulling vacuums. (Stock cylinders are normally available for all frame sizes, see illustrations.)
- For capacities requiring from 7½ to 150 horsepower. (Six frame sizes are available.)
- For continuous full-load operation day after day, week after week.
- For handling poisonous, inflammable, or other gases where leakage must be avoided.
- Where compressed air or gases must be free of all traces of oil. (Type NL cylinders require no oil, glycerine, grease or water for lubrication.)
- Where a future change in pressure conditions may call for a change in cylinder sizes.
- Where power cost is an important factor.
- To act as an economical standby unit for larger compressors whose full capacity is not required at all times.

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1-347 11 Broadway, New York 4, N. Y.

COMPRESSORS • CONDENSERS • AIR & ELECTRIC TOOLS • TURBO BLOWERS • PUMPS • ROCK DRILLS • GAS & DIESEL ENGINES

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Bethlehem, Pa.

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BLAYNE M. BLEAK
Practice Man
Kaiser Steel Corp.
Fontana, Calif.

JOHN G. BONDY
Engineering Department
Republic Steel Corp.
Cleveland, Ohio

JAMES J. BRIGGER
Asst. Supt. Hot Mill
Dominion Foundries & Steel Ltd.
Hamilton, Ontario, Canada.

LESTER J. DAVIS
General Foreman
Detroit Steel Corp.
New Boston, Ohio

WILLIAM R. DUNN
Hot Mill Turn Foreman Sheet Mill
Republic Steel Corp.
Albama City, Ala.

S. FEIGENBAUM
Chief Industrial Engineer
Jones & Laughlin Steel Corp.
Pittsburgh, Pa.

THOMAS V. FERGUSON
Foreman Sub Station and Test
United States Steel Co.
Edgar Thomson Works
Braddock, Pa.

CHARLES W. FINKL
Plant Engineer
A. Finkl & Sons Co.
Chicago, Ill.

JAMES L. FOX
Engineer Trainee
Lukens Steel Co.
Coatesville, Pa.

WILLIAM GATZY
Electrical Engineer
United States Steel Corp.
Homestead District Works
Munhall, Pa.

W. J. GIBBONS
Project Planning Engineer
Columbia-Geneva Steel Division
United States Steel Corp.
San Francisco, Calif.

RALPH P. GIVENS
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Bethlehem Steel Co.
Bethlehem, Pa.

CHARLES E. HAYDEN
Rolling Mill Foreman
United States Steel Corp.
Fairless Works
Fairless Hills, Pa.

T. E. HETRICK
Asst. Supt. Cold Mill and Pickling Dept.
Newport Steel Co.
Newport, Ky.

JOHN F. HOFFMAN
Staff Engineer Rolling Mills
Kaiser Steel Corp.
Fontana, Calif.

FRED L. HUSTON
Roll Designer
T. C. & I. Division
United States Steel Corp.
Birmingham, Ala.

THOMAS E. JAMES
General Foreman, Elec-Mech. Maintenance
Bethlehem Steel Co.
Bethlehem, Pa.

GEORGE EDWARD KEIFER
Acting Asst. Supt. Mech. Dept.
Republic Steel Corp.
Warren, Ohio

RAYMOND M. KLAUCK
Open Hearth Supervisor
Columbia Geneva Steel Div.
United States Steel Corp.
Geneva, Utah

JACK B. KOLBAS, JR.
Draftsman
Electrical Dept.
Bethlehem Steel Co.
Lackawanna, N. Y.

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American Bridge Division
United States Steel Corp.
Ambridge, Pa.

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Granite City, Ill.

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Sparrows Point, Md.

EARL E. MILLER
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Fontana, Calif.

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Sintering Plant
Bethlehem Steel Co.
Bethlehem, Pa.

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Inland Steel Co.
East Chicago, Ind.

NORMAN E. PRICE
Supervising Project Engineer
Kaiser Steel Corp.
Fontana, Calif.

FRANK H. RAFFEL
General Turn Foreman, Mechanical Dept.
Republic Steel Corp.
Cleveland, Ohio

JUAN JOSE RE
Chief Engineer at Rosario Plant
"Acindar" Industria Argentina de Aceros
Rosario de Santa Fe Argentina
South America

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Detroit Steel Corp.
Portsmouth Division
Portsmouth, Ohio

WILLIAM R. ROESCH
Asst. Supt. of Maintenance
Jones & Laughlin Steel Corp.
Cleveland, Ohio

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Atlas Steels Limited
Welland, Ontario, Canada

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Special Director
Ductile Steels Ltd.
Willenhall
Staffs, England

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Draftsman
Bethlehem Steel Co.
Lackawanna, N. Y.

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Electrical Engineer
Bethlehem Steel Co.
Lackawanna, N. Y.

WALTER W. TRYON
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United States Steel Corp.
Pittsburg, Calif.

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Roller
United States Steel Corp.
Fairless Works
Fairless Hills, Pa.

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Construction Engineer
Jones & Laughlin Steel Corp.
Aliquippa, Pa.

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Asst. Engineer, Mechanical Dept.
Bethlehem Steel Co.
Sparrows Point Plant
Baltimore, Md.

RAY E. WILDING
Roll and Guide Design Engineer
United States Steel Corp.
Fairless Works
Fairless Hills, Pa.

LAWRENCE H. WRIGHT
Foreman Technical Operating Training Program
Republic Steel Corp.
Warren, Ohio

FREDERICK C. ZIESER
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Phoenix Iron & Steel Co.
Phoenixville, Pa.

Associate

JESSE E. BAILEY
Asst. to Marketing Manager
Western Gear Corp.
Lynwood, Calif.

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Joy Mfg. Co.
St. Louis, Mo.

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Kaiser Engineers Division
Henry J. Kaiser Co.
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General Electric Co.
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DuBois Engineering & Mfg. Corp.
Hammond, Ind.

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Manufacturers Representative
DeShazo & Thomas
Birmingham, Ala.

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Mohammedi Re-Rolling Mills
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Philadelphia Gear Works, Inc.
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JOSEPH H. KIRKPATRICK
Electrical Engineer
United Engineers & Constructors, Inc.
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E. G. LITTLE
Development Engineer
Signode Steel Strapping Co.
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DONALD R. LOWRY, JR.
Sales Engineer
Ingersoll-Rand Co.
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ROBERT EUGENE McNAMARA
Application Engineer
Western Gear Corp.
Lynwood, Calif.

GLENN C. MERKLEY
Manager Industrial Products Division
The National Supply Co.
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The Wilkoff Co.
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Peninsular Grinding Wheel Sales Corp.
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Application Engineer
Brown Instrument Division
Minneapolis Honeywell Reg. Co.
Philadelphia, Pa.

MARTIN PRESTON
Engineer Chief of Division
The Wellman Engineering Co.
Cleveland, Ohio

ROBERT E. SELESKI
Design Engineer
Birdsboro Steel Foundry & Machine Co.
Birdsboro, Pa.

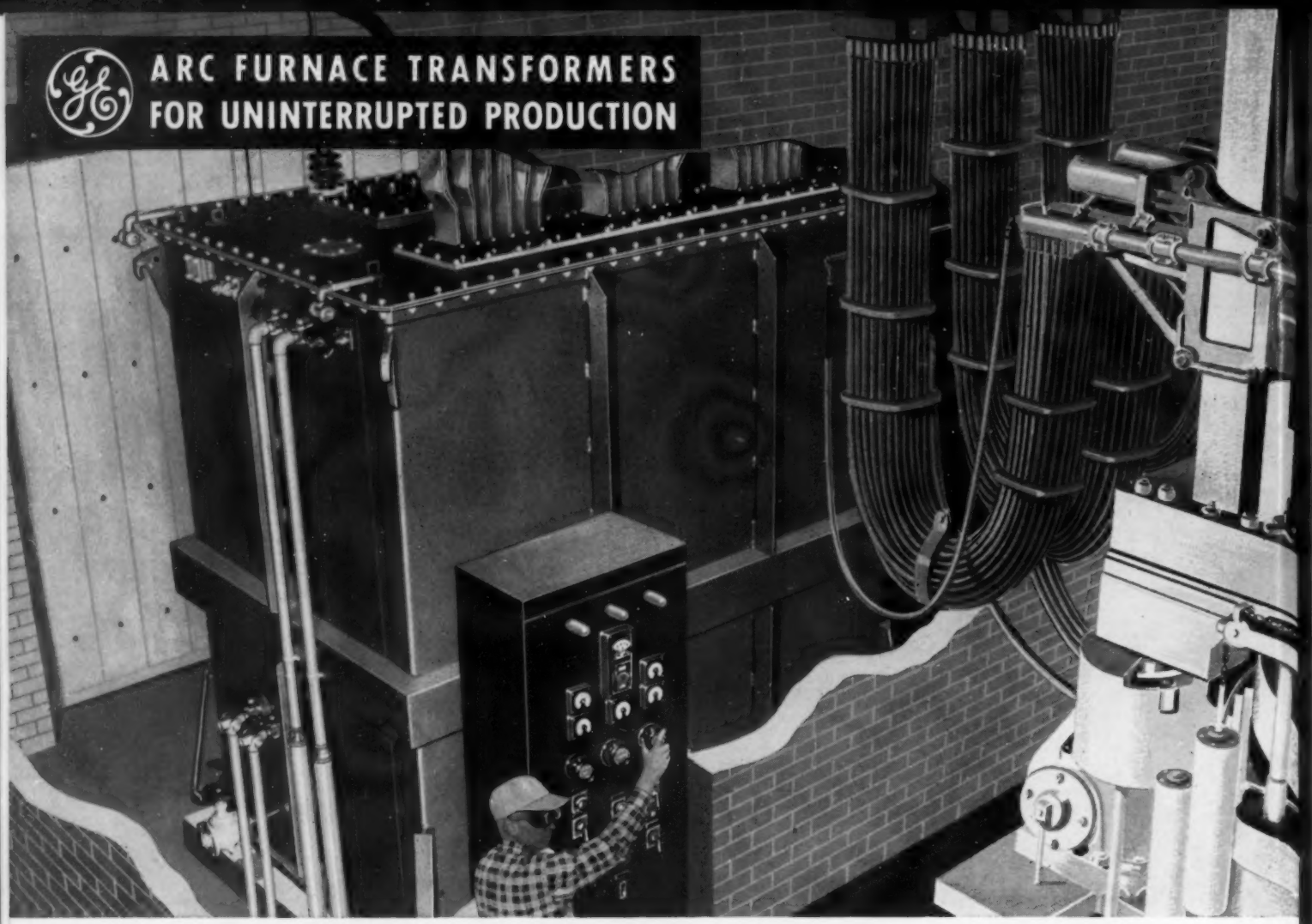
RICHARD A. SMUCKER
Application Engineer
E. W. Bliss Co.
Salem, Ohio

LENNART STROMBERG
Junior Engineer
Kaiser Engineers
Oakland, Calif.

LINCOLN L. SWIFT
Engineer
Wellman Engineering Co.
Cleveland, Ohio

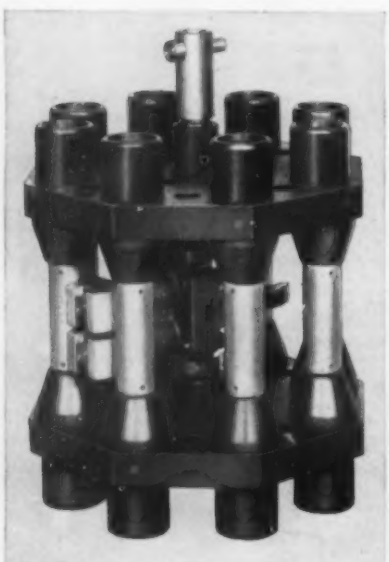
E. F. THOMAS
Manufacturer's Representative
DeShazo & Thomas
Birmingham, Ala.

RICHARD E. VAUGHN
District Sales Manager
Chicago District
Peninsular Grinding Wheel Co.
Detroit, Mich.



YOU CAN COUNT ON PRODUCTION CONTINUITY WHEN YOU INSTALL A GENERAL ELECTRIC ARC FURNACE TRANSFORMER.

Not one G-E tap-changer contact failure since wedge-type introduction in 1938



HEART OF TAP-CHANGER mechanism is the circular arrangement of contacts. Made of specially tin-plated copper, they have high current-carrying ability with low contact temperature, and a wedging action which assures good contact under all operating conditions.

Since the introduction 18 years ago of the General Electric wedge-type tap changer, no contacts have ever separated, carbonized, welded, or otherwise failed according to our records. This is another example of the outstanding record of reliability established by G-E arc-furnace transformers.

The tap changer itself is designed with liberal electrical, mechanical, and thermal safety factors. It can, in fact, withstand the full short-circuit current of the transformer without injury. Furthermore, a special safety interlock between tap-changer driving mechanism and primary circuit breaker prevents any chance of tap-changer operation under load. Because of the tap changer's reliability, it can be strategically located in the main tank close to the windings, thus permitting great savings in floor area.

Tap changers are only one of many features which make G-E arc furnace transformers your best bet for long-term reliability. Others include core-type construction with inherently strong circular-concentric windings, dust-tight bus-bar seal, and high-pressure-tested cooling systems.

For complete details contact your nearest G-E apparatus Sales Office or write for Bulletin GEA-6236 to General Electric Company, Section 422–27, Schenectady 5, New York.

Progress Is Our Most Important Product

GENERAL ELECTRIC

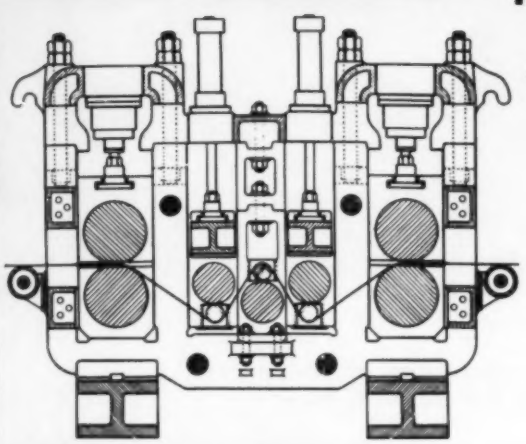
F&Y TRIPLE SCALE BREAKER

Speeds Pickling with the New

"YOUNGSTOWN"

High Speed Continuous Strip Pickling Line

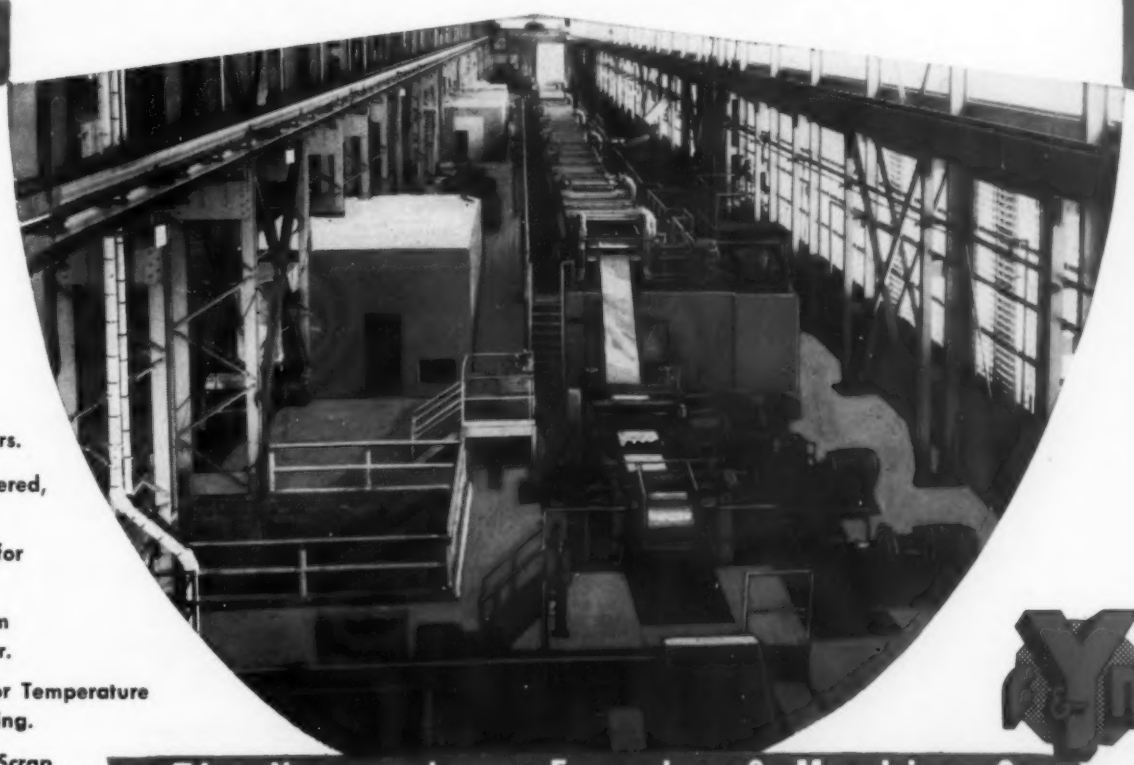
...Better Pickling with Less Acid and Lower Cost!



See our new, pull thru type, TRIPLE SCALE BREAKER, —a revolutionary improvement that eliminates the need for a Pinch Roll Stand in a modern Pickling Line. Investigate this and other new "YF&M" advantages. Whatever your pickling requirements,—complete new lines, revamping of existing lines, new tanks, rubber-covered rolls, Paralloy pinch rolls, any pickling line equipment,—get the benefit of our 70 years' experience. Consult "Youngstown" on how to speed up your pickling, cut acid consumption and make your operation more profitable.

features—

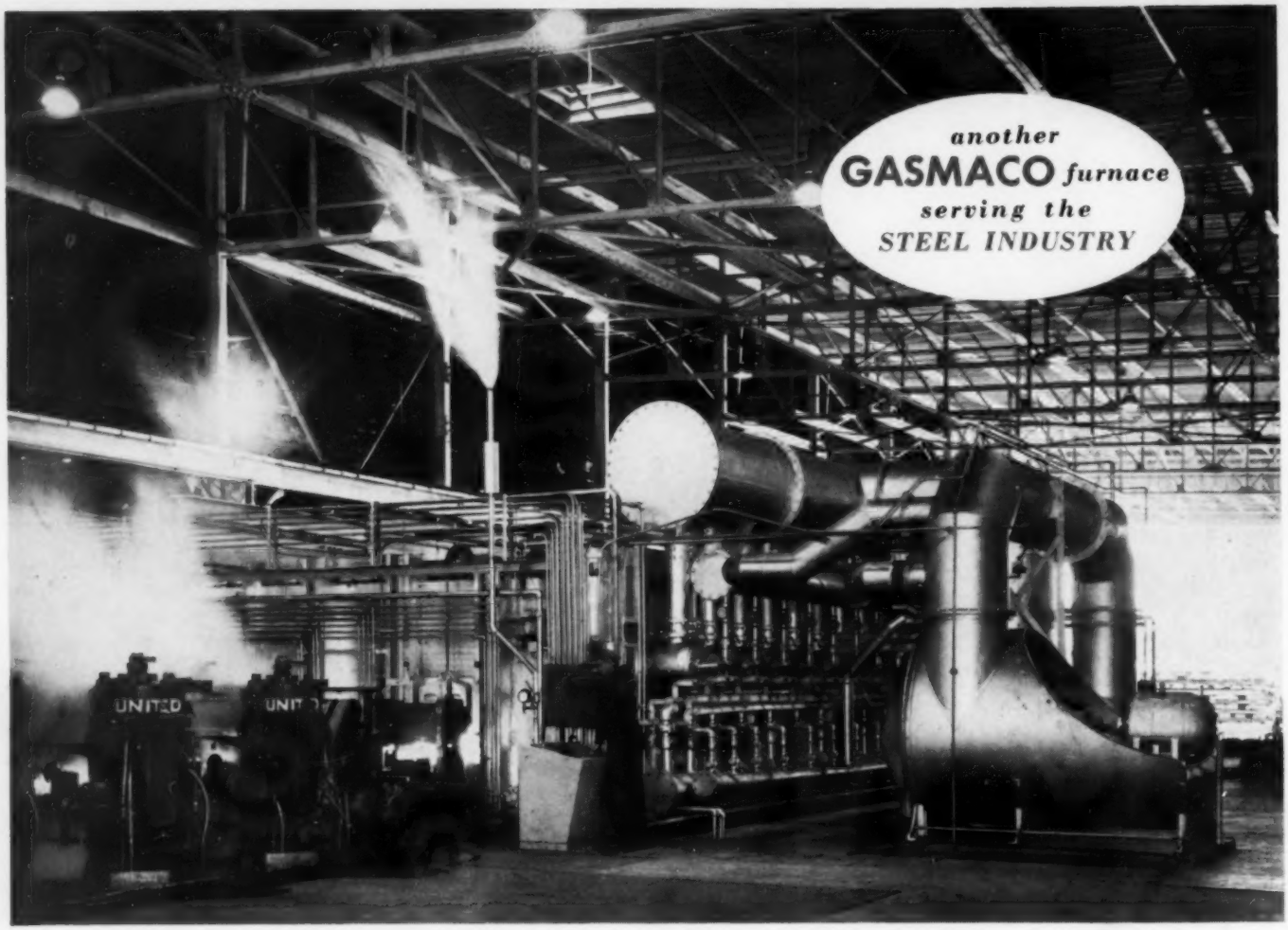
- Cone Type Payoff with Strip Opener.
- Triple Processor with Roller Leveller.
- Flash Welding and Mechanical Stitching.
- Pull-Thru Type Triple Scale Breaker.
- Single Cycle Up-Cut Shears.
- Heavy Duty Rubber Covered, Brick Lined Steel Tanks.
- Magnetic Loop Control for Acid Tanks.
- Fume Exhaust System —Roto Clone Scrubber.
- Automatic Control for Temperature and Acid Proportioning.
- Side Trimmer with Scrap Cutting or Balling
- Up-Coiler with Strip Oiling System.
- Entry and Exit Coil Conveyors



The Youngstown Foundry & Machine Co.

SERVING INDUSTRY SINCE 1885

Youngstown, Ohio



BILLET HEATING

60-ton Furnace at Wickwire Spencer Steel Division, The Colorado Fuel and Iron Corporation

On this Gas Machinery furnace, reverse flowing of spent gases prevents pile-ups at charge end. Gases pass over the billets and back under before being discharged.

Special holding burners eliminate problems normally encountered in resuming operations after a mill delay.

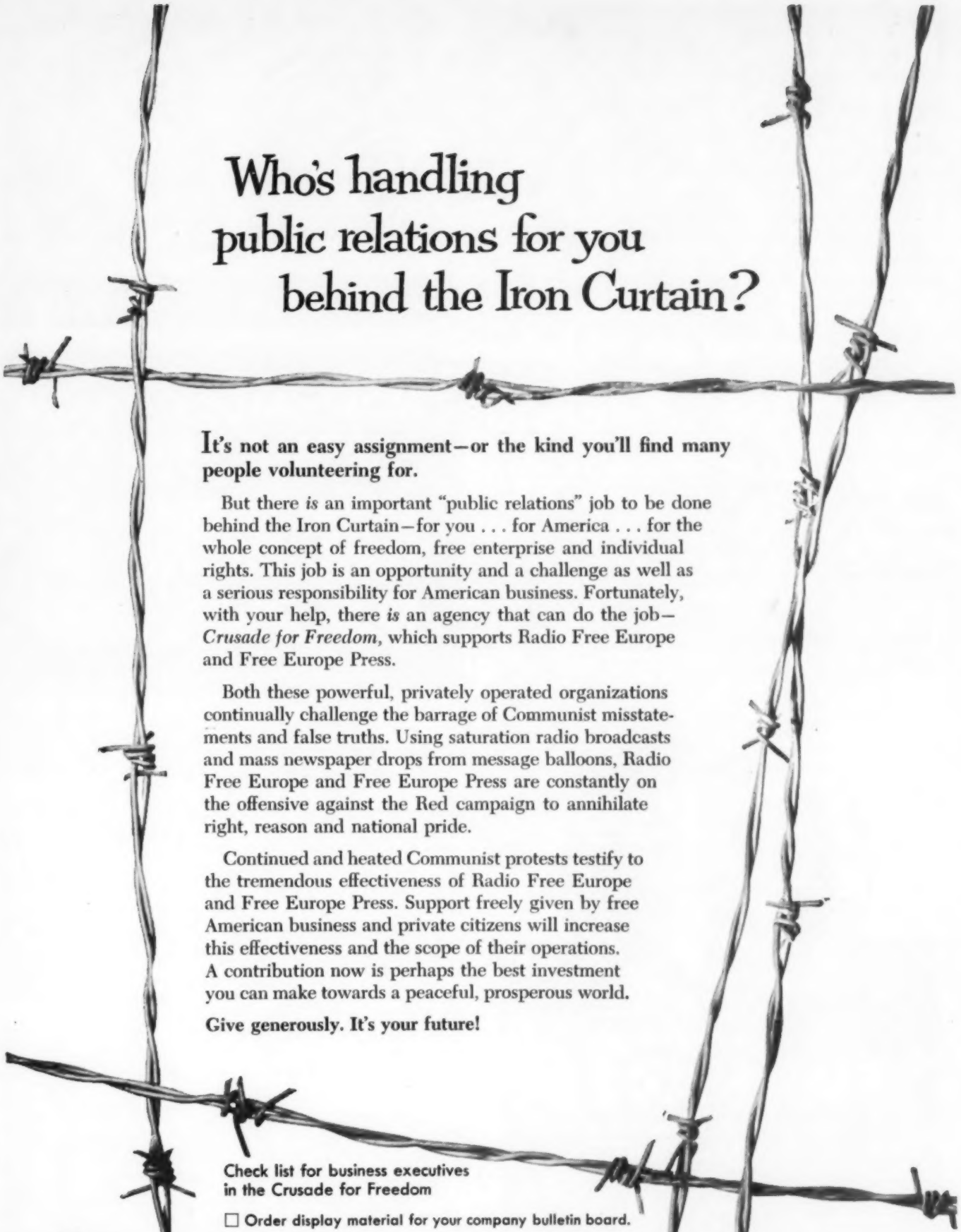
This furnace is supplied with recuperation . . . has modern combustion and control equipment . . . is designed to suit the mill layout.

GASMACO pusher-type furnaces range up to 150 tons — single-zone, double-zone, triple-zone, five-zone. THE GAS MACHINERY COMPANY, 16128 Waterloo Road, Cleveland 10, Ohio. In Canada: The Gas Machinery Co. (Canada) Ltd., Hamilton, Ontario.

✓ *Check first with GASMACO for latest industrial furnace designs.*

THE **gas machinery** COMPANY

GAS PLANT EQUIPMENT
AND INDUSTRIAL FURNACES



Who's handling public relations for you behind the Iron Curtain?

It's not an easy assignment—or the kind you'll find many people volunteering for.

But there *is* an important "public relations" job to be done behind the Iron Curtain—for you . . . for America . . . for the whole concept of freedom, free enterprise and individual rights. This job is an opportunity and a challenge as well as a serious responsibility for American business. Fortunately, with your help, there *is* an agency that can do the job—*Crusade for Freedom,* which supports Radio Free Europe and Free Europe Press.

Both these powerful, privately operated organizations continually challenge the barrage of Communist misstatements and false truths. Using saturation radio broadcasts and mass newspaper drops from message balloons, Radio Free Europe and Free Europe Press are constantly on the offensive against the Red campaign to annihilate right, reason and national pride.

Continued and heated Communist protests testify to the tremendous effectiveness of Radio Free Europe and Free Europe Press. Support freely given by free American business and private citizens will increase this effectiveness and the scope of their operations. A contribution now is perhaps the best investment you can make towards a peaceful, prosperous world.

Give generously. It's your future!

Check list for business executives in the Crusade for Freedom

- ☐ Order display material for your company bulletin board.
- ☐ Plan a paycheck stuffer to fully acquaint your employees with the importance of the Crusade for Freedom.
- ☐ Plan to conduct an in-company solicitation.
- ☐ Match employee funds with *your Truth Dollars.*

PUBLIC SERVICE ADVERTISING COUNCIL

For campaign material and information write **CRUSADE FOR FREEDOM,** 345 East 46th St., N. Y. C. 17.

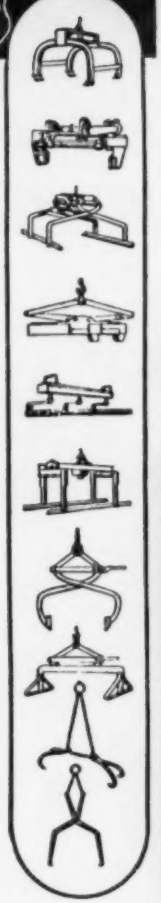
MANSAVER GRABS®

HELPED TO MODERNIZED Wheeling Steel's 6 Plants!

Wheeling Steel Corp., major producer of rolled sheets and roofing, coils, black and tin plate, continuous weld pipe and many fabrications, uses Mansaver Grabs to handle its sheet and coil output at the plants "arrowed" on the drawing here.

However, Mansaver Grabs, can cut your handling time just as easily as they are cutting Wheeling's. Write for catalog, and ask us how.

MANSAVERS are built for continuous operation—not low first cost



MANSAVER INDUSTRIES, INC.
3116 East St., New Haven, Conn.

Call or Write STAMCO for...

Corrugating and Complete Line of Culvert Equipment—Slitting and Coiling Equipment for Ferrous and Non-Ferrous Material in All Capacities—Warehouse and Steel Mill Cut to Length Lines for Shearing and Levelling Sheets from Coils—Shears for Shearing Sheets and Plates Both Underdriven and Overdriven Types in all Capacities up to 1¼" plate.

STAMCO, Inc., New Bremen, Ohio

NOW—ALLOY CHAIN REPAIR SERVICE

in PITTSBURGH and HAMMOND

For greater safety and economy, have your Alloy Sling Chains returned to either our Pittsburgh or Hammond plant for repair, inspection and testing, at nominal cost.

S. G. TAYLOR CHAIN CO., Hammond, Ind.
and 3505 Smallman St., Pittsburgh 1, Pa.

THE ELECTRIC FURNACE CO. Salem, Ohio
EF
Gas Fired, Oil Fired and Electric Furnaces.

HEAT PROCESSING FURNACES

for the Steel Industry

Equipment for annealing, normalizing, galvanizing and other heat processing of high and low carbon steel, stainless, silicon and other alloys—strip, sheet, wire, tubing and other ferrous and non-ferrous products.

Submit your problems to EF engineers
See our advertisements in preceding and following issues

THE ELECTRIC FURNACE CO.
Salem - Ohio
GAS-FIRED, OIL-FIRED AND ELECTRIC FURNACES
FOR ANY PROCESS, PRODUCT OR PRODUCTION

I Wish . . .

to enter one year's subscription for the IRON AND STEEL ENGINEER at $7.50 per year:

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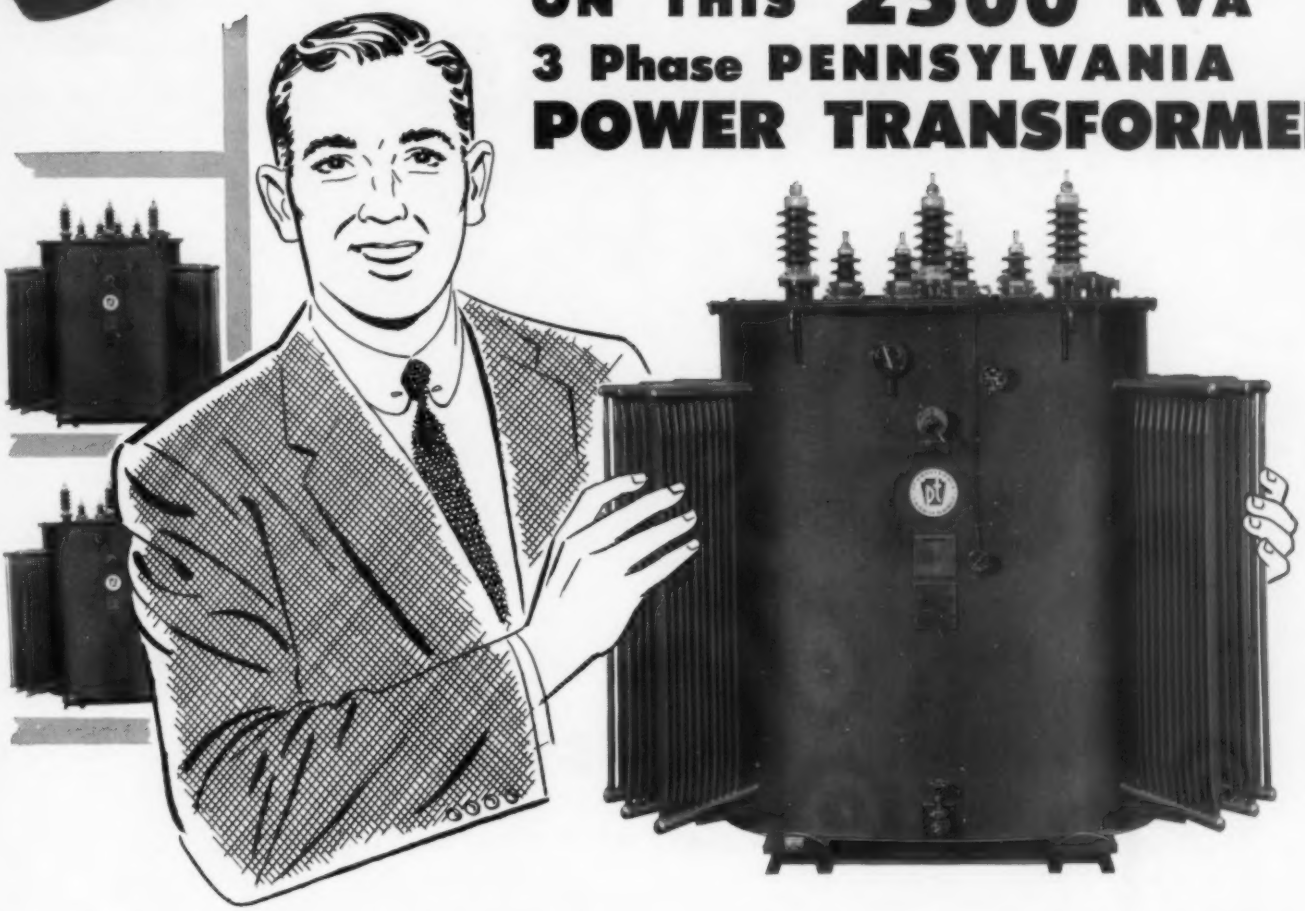
Mail this coupon to:

Association of Iron and Steel Engineers
1010 Empire Building
Pittsburgh 22, Penna.

Save $943.00 AND MORE

ON THIS 2500 KVA 3 Phase PENNSYLVANIA POWER TRANSFORMER



Actually you can save as much as $1055* on 2500-kva, three-phase transformers like this one — by taking advantage of the cost reductions Pennsylvania is able to pass along to you when you specify *Standard Parts* power transformers. "Standard Parts" means that kva, voltages, and accessories are within the range of standardized units outlined in ASA Standards C57.12b.

Similar savings — *up to 8% of the basic cost of a transformer* — can be yours for any units 833 kva through 5000 kva single phase, and 750 kva through 10,000 kva three phase, in voltages up to 69 kv.

And . . . your initial dollar savings are just part of the story. You also . . .

Get quicker deliveries, because designs are already made up and many standard parts are already in stock.

Save on installation, because most *Standard Parts* power transformers are shipped completely assembled and ready to connect to your lines.

Save on maintenance, because Pennsylvania *Standard Parts* power transformers feature all-sealed construction, which means there are no external auxiliary tanks and fittings to maintain.

If your transformer requirements fall within the sizes listed above, make it a point to find out about Pennsylvania *standard parts* power transformers. You may save as much as 8%!

* 34,400 volts is a standard high voltage rating. The 31,350△ rating of this transformer is within the optional high voltage range, adding 1% to the net cost of the *Standard Parts* transformer.

PENNSYLVANIA TRANSFORMER COMPANY

A McGraw Electric Company Division **CANONSBURG, PA.** *Greater Pittsburgh District*

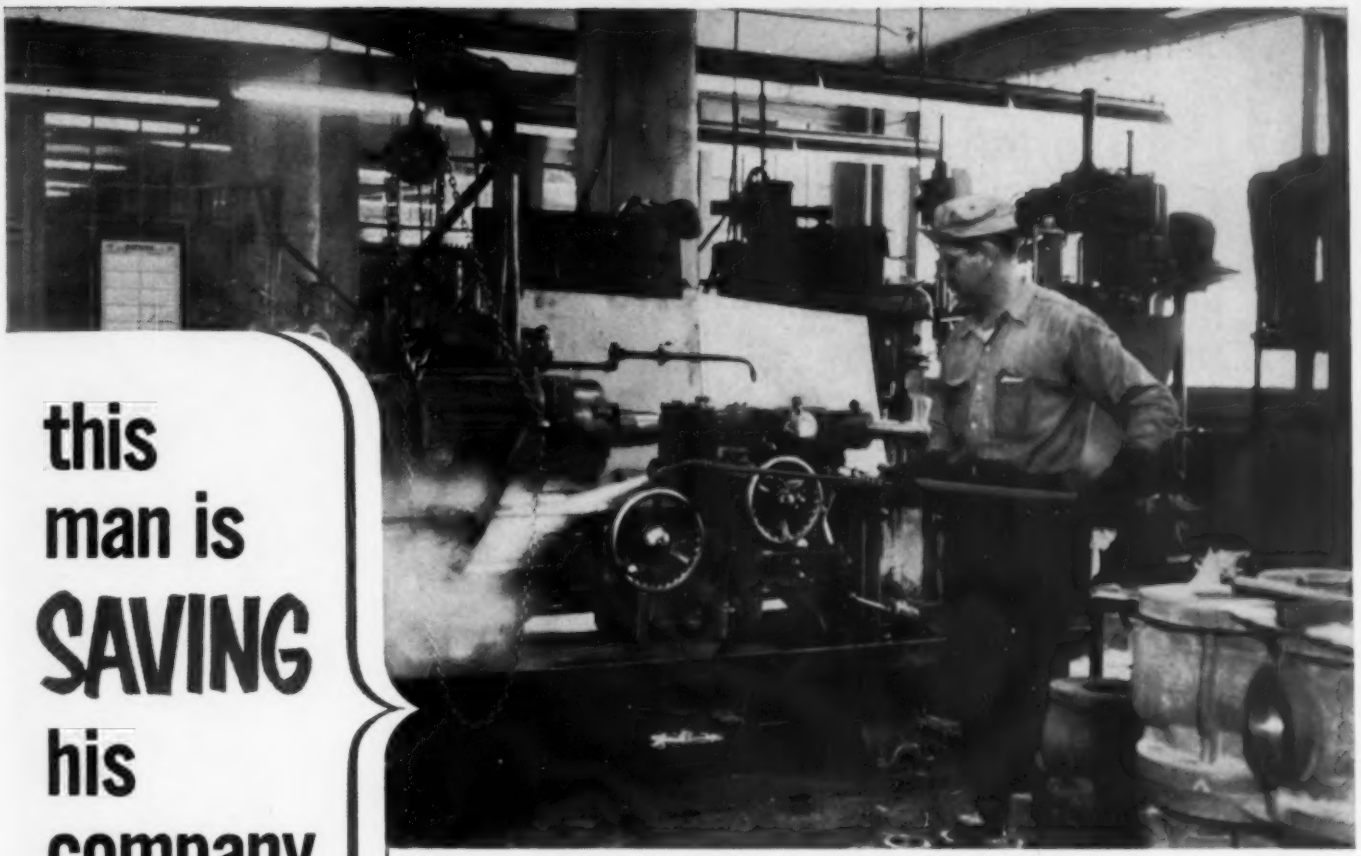
Now a new standard of safety in low-voltage switchgear

Test position with doors closed

This exclusive I-T-E low voltage switchgear feature establishes a new standard of safety in testing circuit breakers. It offers the additional advantages of reduced handling; less maintenance; convenient "tagging out"; better dust protection; easier circuit identification. And all are yours at no increase in cost in the compact, modern design of I-T-E low-voltage switchgear.

For complete information, contact your nearest I-T-E sales office. Or write for Bulletin 6004B. I-T-E Circuit Breaker Company, 19th & Hamilton Sts., Philadelphia 30, Pa.

I-T-E CIRCUIT BREAKER COMPANY
Switchgear Division



this man is SAVING his company money...

SPEEDING PRODUCTION

He's stripping oily grime from machine tools with Hypressure Jenny *before repairs or repainting.* He's *saving his company* money, because he is doing the job in one-sixth of the time taken by hand methods. Also it is a known fact that when mechanics work on clean equipment, unhampered by grease and grime, production steps up . . . job time is shortened . . . costs are reduced.

But that's only half of it!

Besides cleaning all types of production machinery, tools and equipment, Jenny saves up to 90% of the time and labor costs of cleaning floors, walls, windows, and lavatories . . . reduces fire hazard; increases plant safety; and speeds production through better working conditions.

If you would like to know more about HYPRESSURE JENNY STEAM CLEANER and the many ways it can save your company money . . .

WRITE, OR MAIL THE COUPON TODAY! No Obligation.

HYPRESSURE **Jenny** STEAM CLEANER

Without obligation send me complete information on HYPRESSURE JENNY STEAM CLEANER

Name_____ Title_____

Company_____

Address_____

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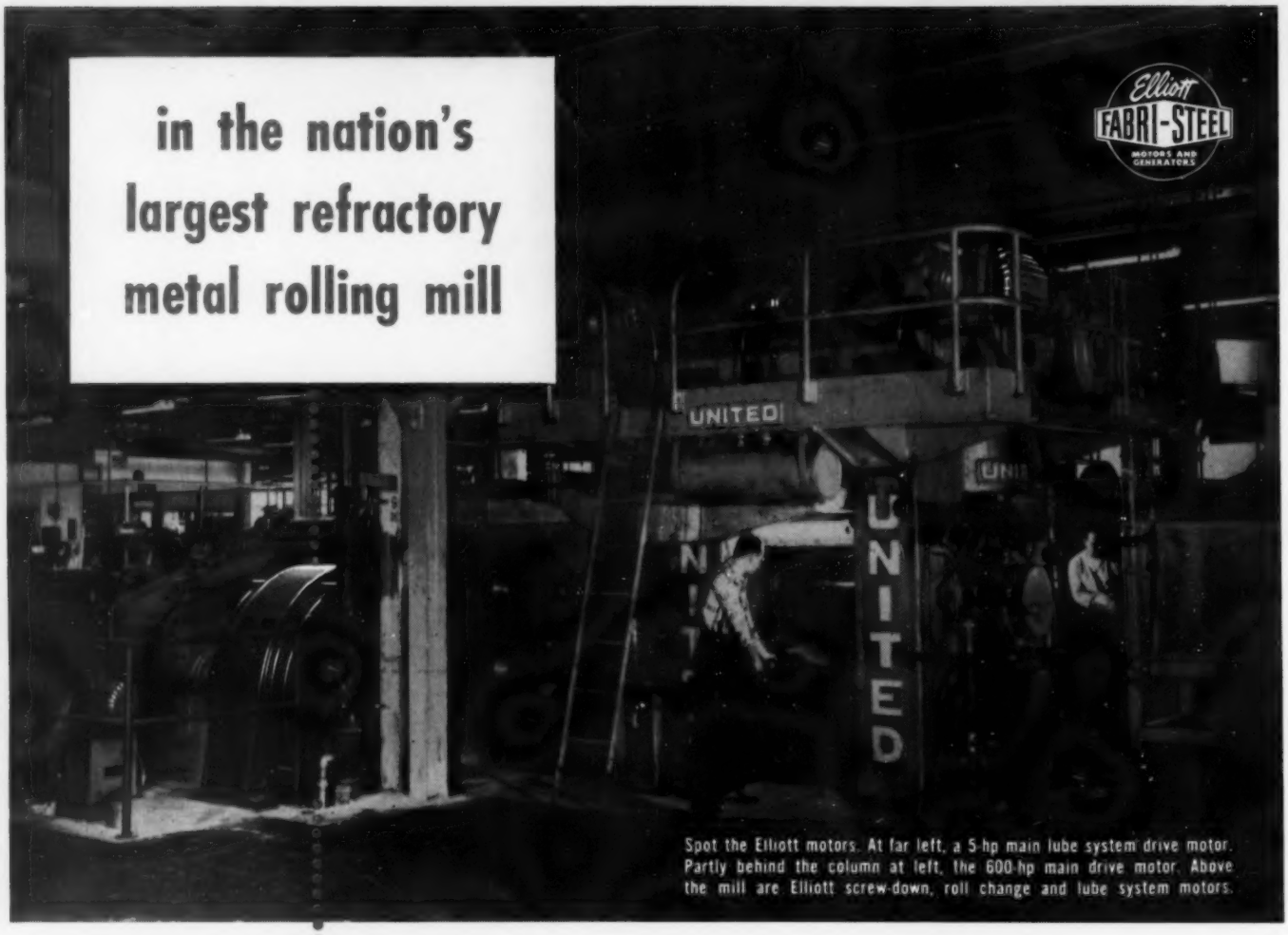
HYPRESSURE JENNY DIVISION **HOMESTEAD VALVE MANUFACTURING COMPANY**

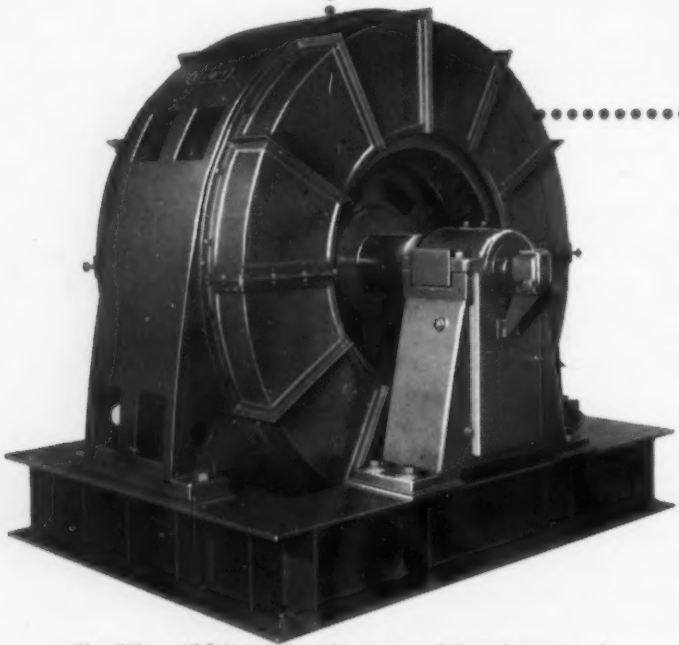
P. O. BOX 21 *"Serving Since 1892"* CORAOPOLIS, PA., U.S.A.

in the nation's largest refractory metal rolling mill

Elliott FABRI-STEEL MOTORS AND GENERATORS



Spot the Elliott motors. At far left, a 5-hp main lube system drive motor. Partly behind the column at left, the 600-hp main drive motor. Above the mill are Elliott screw-down, roll change and lube system motors.



The Elliott 600-hp main drive motor. It is a four-speed, constant horsepower, two-winding, consequent pole squirrel-cage induction motor which develops not less than 250 percent pullout torque at all four speeds.

ELLIOTT MOTORS

Fansteel Metallurgical Corporation's modern, new 26 in. by 36 in. rolling mill provides greatly increased manufacturing capacity for such metals as tantalum, tungsten and molybdenum. Elliott motors furnish power at key points throughout the mill.

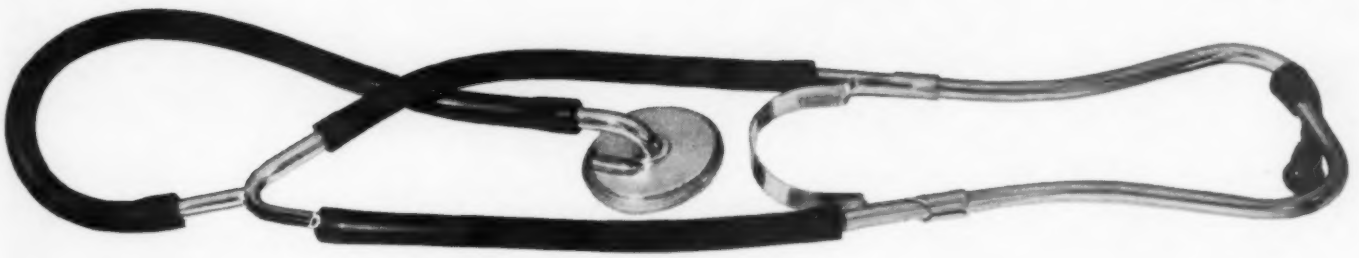
Largest of these is an Elliott 600 hp main drive induction motor which can be operated at four speeds, forward or reverse—450, 600, 900 or 1200 rpm. Pushbutton control is also provided for inching or jogging. The control is electrically interlocked so that the mill does not start until the oil pumps are running and oil pressure is normal. In addition, a number of Elliott Crocker-Wheeler 15 hp and smaller motors are on auxiliary drive service. Elliott motors are at home in metal mill service. Their rugged construction, careful design and dependable operation assure the highest standards of performance. Elliott Company, Ridgway Division, Ridgway, Pa.

ELLIOTT Company

R5-3

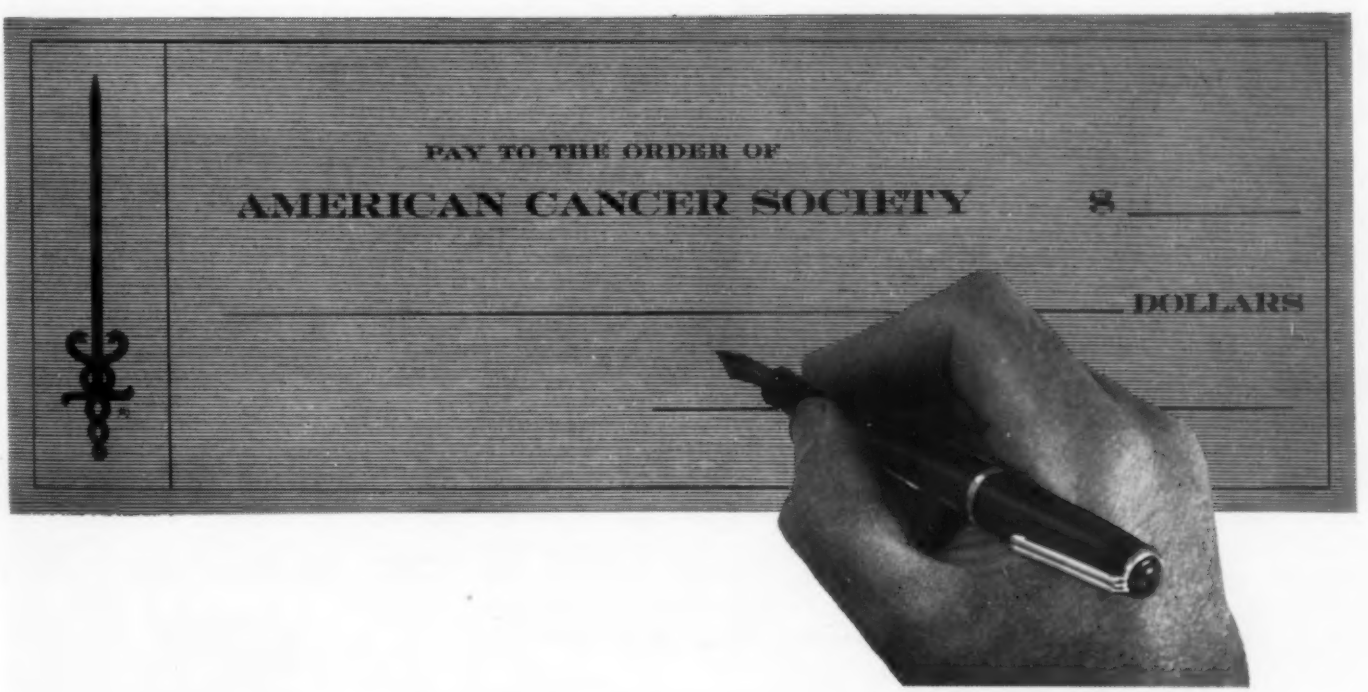
A checkup

Of every 100 persons who get cancer 25 will be saved, 75 will die. Of these, many will die *needlessly*, because with present knowledge they could be saved by early detection and prompt treatment. Play fair with yourself and your family . . . have that cancer checkup soon.



and a check

There has never been enough money to carry on all the research that needs to be done. Can you afford to remain indifferent to the enemy that strikes 1 out of every 4 Americans? Your donation—large or small—can help save lives. Someday, perhaps your own.



Poundage and Tonnage in Forged-Steel Rolls

When considering steel rolls, mill men sometimes think of us in terms of tonnage only. But, as this photograph attests, not all of the rolls we produce are of awesome dimensions. Some, in fact, are so small that their weight is less than a hundred pounds.

That little one across the shopman's knee is a case in point. It wouldn't weigh a hundred pounds wringing wet. But it's proof of the old saying that good things come in small packages. Note the beautiful workmanship from end to end.

At Bethlehem, however, quality also comes in big packages. One example would be that second roll in the photograph. It is a giant that took many weeks to create. At every step along the route, it was given the most exhaustive inspections and tests. Finish-machined it weighs upwards of 22 tons, and its quality matches its size.

You'll find Bethlehem forged rolls dependable, no matter what the size or type. They are recommended for cold-rolling ferrous sheets and strip . . . running-down and finishing operations on copper and brass sheets. . . hot- and cold-rolling aluminum sheets . . . cold-rolling aluminum foil.

BETHLEHEM STEEL COMPANY
BETHLEHEM, PA.

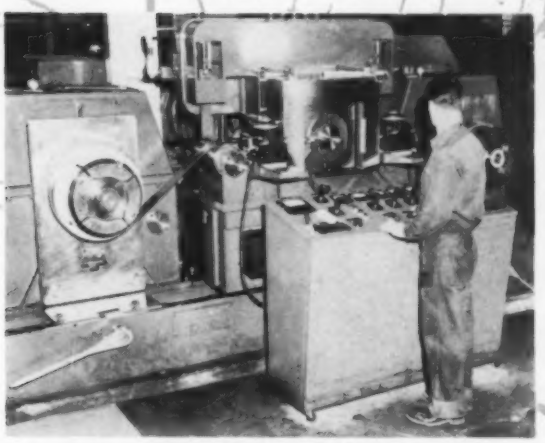
On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. *Export Distributor:* Bethlehem Steel Export Corporation

BETHLEHEM STEEL

BETHLEHEM STEEL

RELIANCE V★S DRIVE®

TAKES ANY QUESTION OUT OF SPECIALTY METAL ROLLING



Top quality specialty-metal for pressure gauges, instrument springs, diaphragms, and other devices is rolled on this highly flexible Sendizimir mill at Beryllium Corporation.

Roughing, breakdown and finish passes are made with precision control, all on one mill, at speeds from 0-400 fpm. Small coils are used to eliminate intermediate annealing.

A Reliance V★S Drive takes any question out of this type of manufacturing . . . by providing close control of tension, variable speed for all gauges, smooth acceleration and deceleration, dynamic braking, and other features. All guess work is eliminated, with improved quality!

Reliance V★S Drives are solving difficult industrial problems everywhere. What's *your* drive problem?

Write for Bulletin D-2311. D-1514

RELIANCE ELECTRIC AND ENGINEERING CO.

CLEVELAND 10, OHIO • OFFICES IN PRINCIPAL CITIES

Canadian Division: Welland, Ontario

CONTINUOUS STRIP ANNEALING in DREVER VERTICAL FURNACES

Saves Time • Reduces Cost

Drever Company has pioneered this striking improvement in Continuous Annealing Furnaces for Tin Plate Strip, Silicon Strip, Blue Plate and other strip products. We predict all major steel mills will anneal by this method. Why don't *you* do it now?

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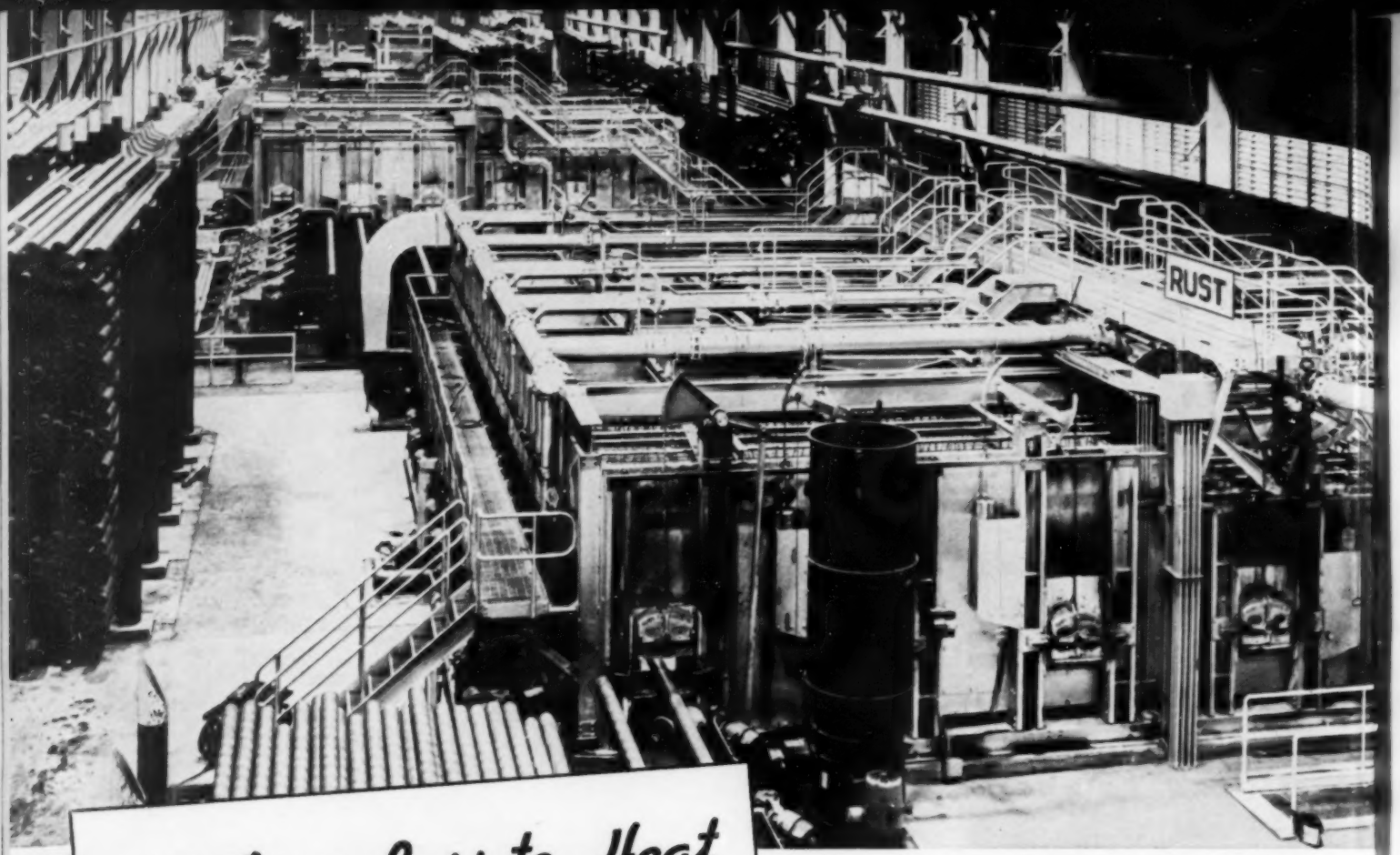

116 Tons Less to Heat in this roof

because of B&W Insulating Firebrick suspended construction

Here's another case where light weight means lower cost. The roof of this walking beam furnace is 2,320 square feet. B&W Insulating Firebrick suspended construction for a 9-inch roof weighs about 30 lbs per square foot, including the weight of rods, hangers, pipe, brick and mortar. This is approximately 100 lbs per square foot less than an arch constructed of heavy firebrick plus insulation having the same heat flow. *This saving means the B&W IFB roof is 116 tons lighter.*

The new walking beam furnace (shown in photograph above) was designed and constructed by Rust Furnace Company for Jones & Laughlin Steel Corporation. Seamless pipe is conveyed into the furnace, moves slowly from left to right on walking beam rails designed and furnished by York-Gillespie Mfg. Co., and passes out the exit door.

Here are the money-saving benefits of B&W suspended construction:

1. Supporting steel is less massive, far less costly. Commercial size steel can be used for roof suspension instead of special castings.

2. B&W Insulating Firebrick heat up and cool down faster. This means lower fuel costs, faster inspection.

3. Furnace temperatures can be changed quickly. When different steels call for different heating schedules, the furnace temperature can be adjusted in minutes instead of hours.

4. Installation costs are lower because these lightweight brick can be handled faster and easier than ordinary heavy firebrick.

For complete information on B&W IFB—the *lightest* weight insulating firebrick, write to B&W today or call your local Refractories Engineer.

This is a cross-sectional drawing of a typical suspended arch arrangement using B&W Insulating Firebrick. It can be used in flat or sloping roofs, nose arches and many other types of suspended furnace construction.

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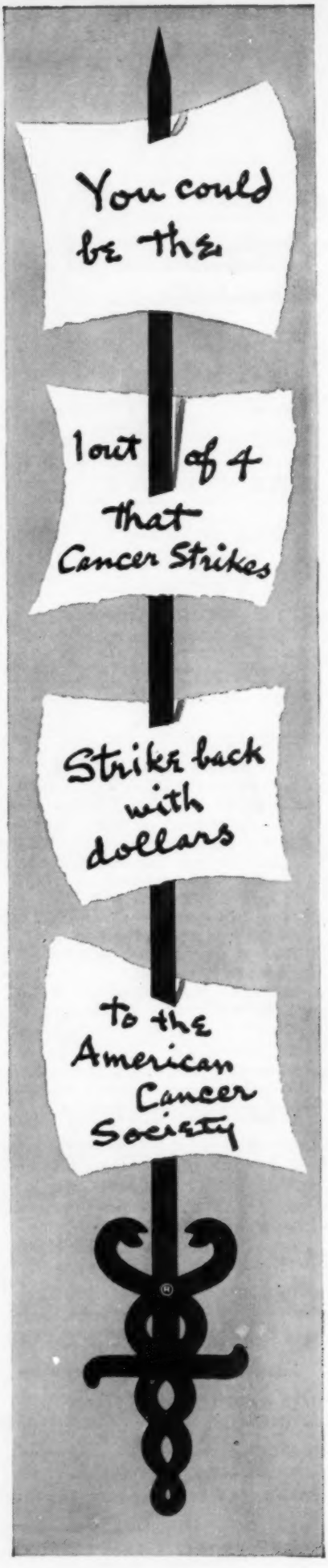
Index to the Year Books and Regional Papers of the American Iron and Steel Institute," compiled by Jeanne McHugh has recently been published by The University of Oklahoma Press, Publishing Div., Norman, Okla. It contains 593 pp., 6 x 9-in., is cloth bound and is priced at $12.50. This index covers the Year Books from 1910 through 1953 omitting the years of 1911 and 1942 when no books were issued. This index has been kept simple, thorough and easy to use. It contains extensive information useful to all searching for information regarding the history and the technical development of the iron and steel industry.

"Dictionary of Mechanical Engineering Terms," revised by Staton Abbey, has recently been published in a seventh edition by the Philosophical Library, Inc., 15 East 40th Street, New York 16, N. Y., price $6.50. This dictionary is published in two parts, modern terms and general and traditional terms. The original compilator of this book was J. P. Horner. This book is better described as a condensed encyclopaedia of mechanical engineering practice with the practical aspects as strongly represented as the theoretical. The continuous progress of industry has introduced many new terms which made necessary this revision.

"Economic Geography of Industrial Materials," edited by Albert S. Carlson, Department of Geography, Dartmouth College, Hanover, N. H., has recently been published by Reinhold Publishing Corp., New York. Book contains 494 pp, 7 x 10¼ in., is cloth bound and sells for $12.50. This publication is a fact-filled handbook of a broad scope deftly prepared by experts on the subject material. It is amply illustrated with maps, tables, charts, and statistics, and covers such factors as location, climate, soil, topography, water resources, minerals, fuels, labor, capital, management, transportation and market; profitable trends, and present and future conditions have been carefully studied and evaluated. Emphasis is placed on raw materials, particularly metals.



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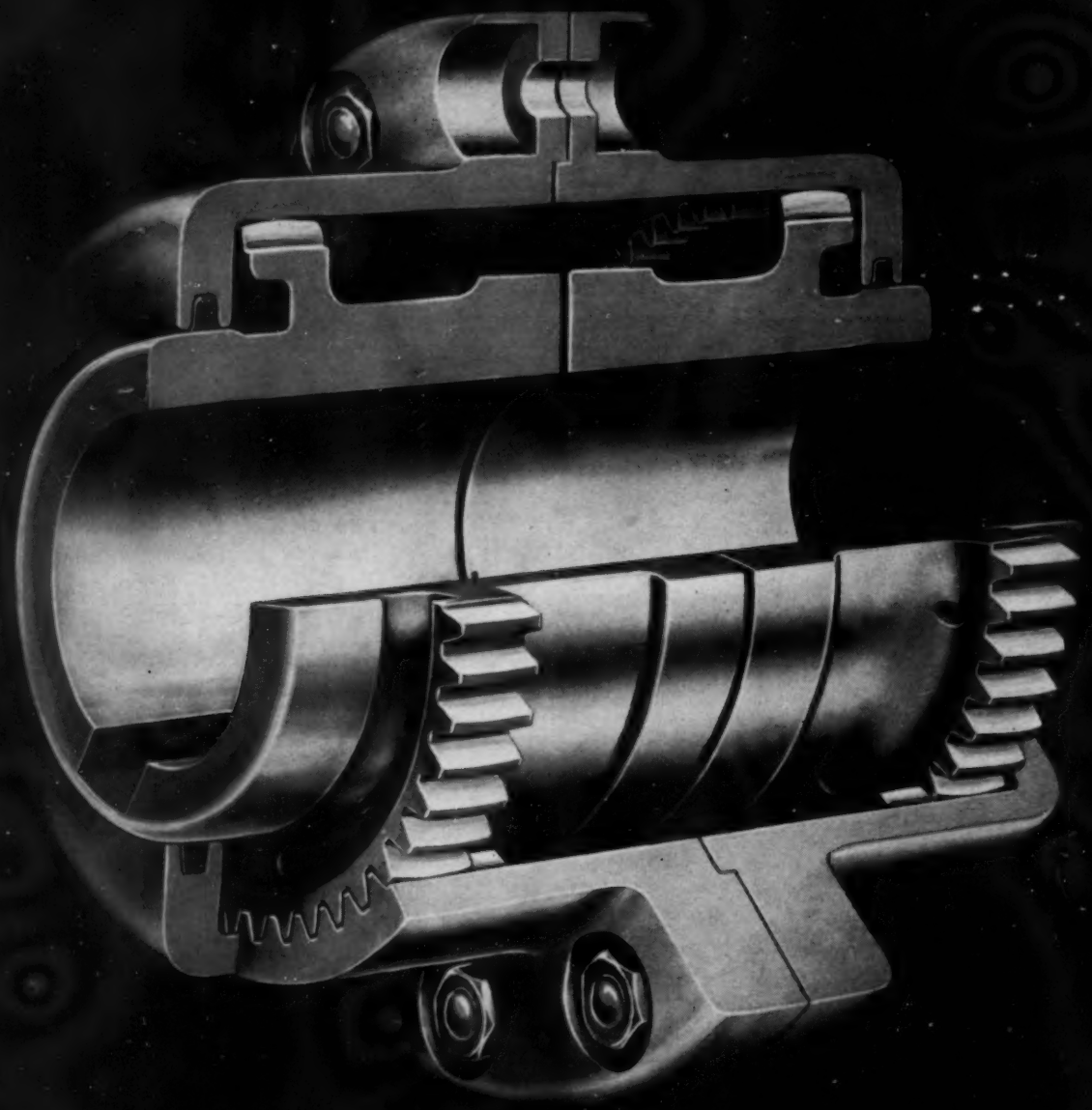

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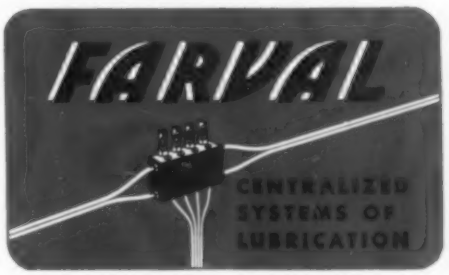

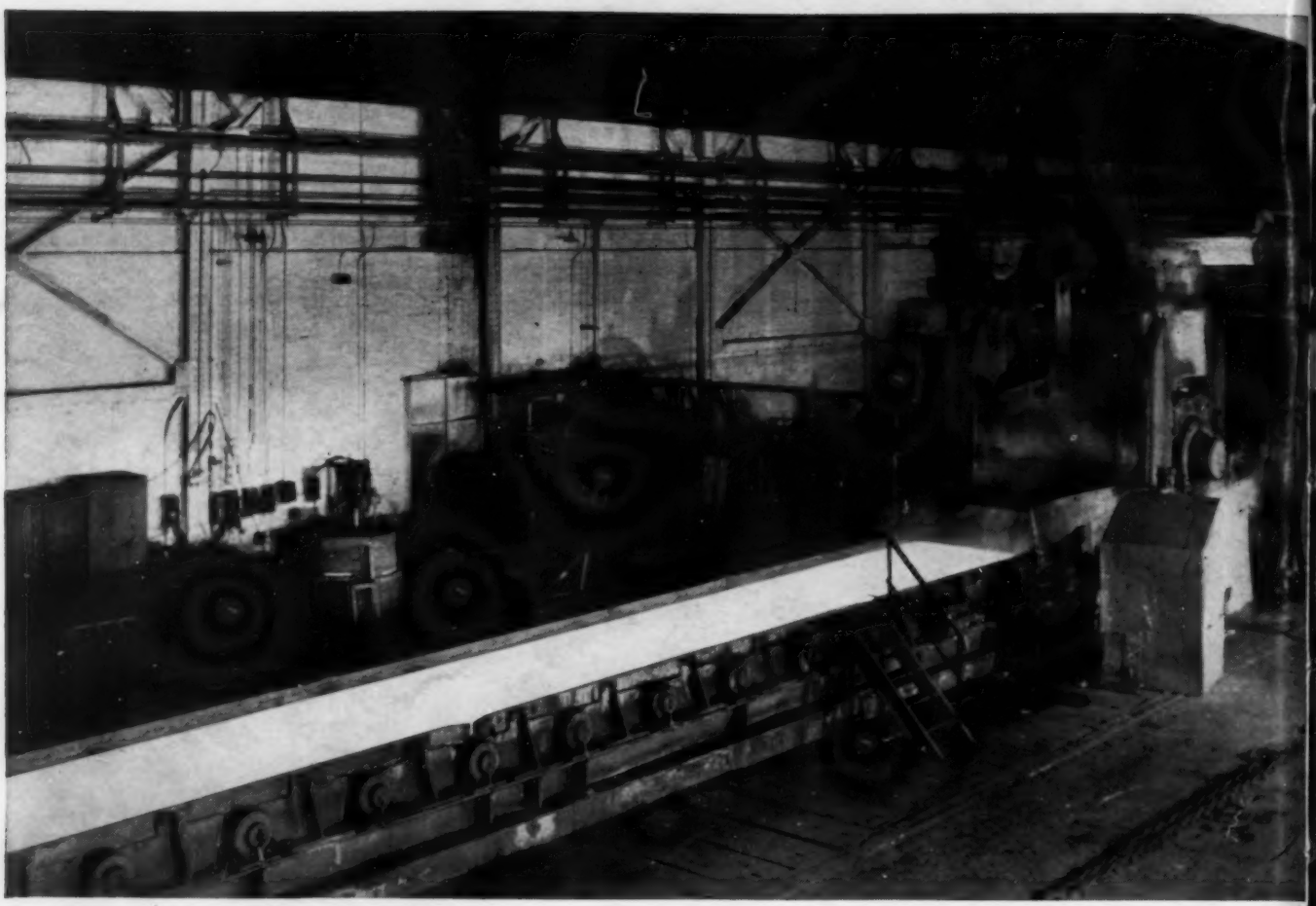

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